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WASTEWATER ENGINEERING AND MANAGEMENT PLAN

FOR

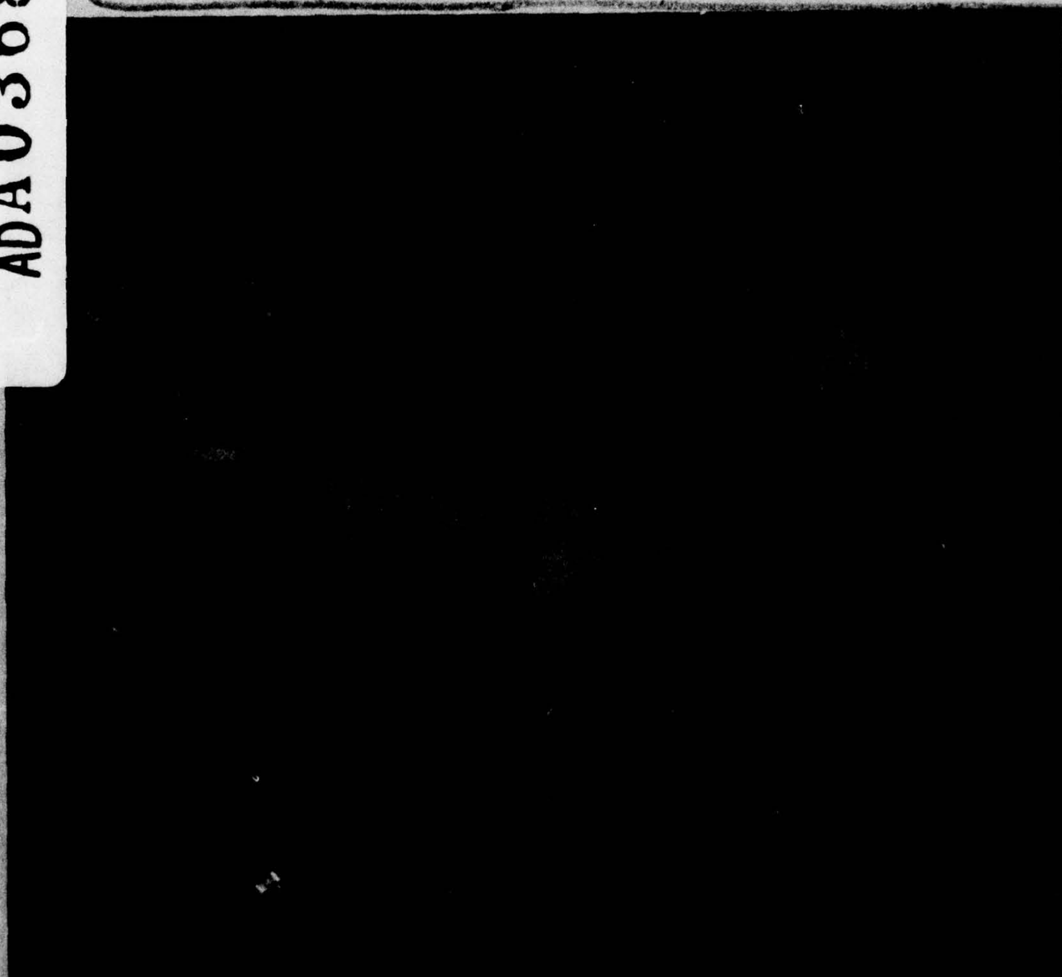
BOSTON HARBOR - EASTERN MASSACHUSETTS METROPOLITAN AREA

EMMA STUDY.

TECHNICAL DATA [redacted] Volume 13B.

SOCIO-ECONOMIC IMPACT ANALYSIS.

'C IMPACT ANALYSIS VOL. 13B



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WASTEWATER ENGINEERING
AND MANAGEMENT PLAN
FOR
Boston Harbor - Eastern Massachusetts Metropolitan Area
EMMA STUDY

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SOCIO-ECONOMIC IMPACT ASSESSMENT

NEW ENGLAND DIVISION
U.S. ARMY CORPS OF ENGINEERS
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Waltham, Massachusetts

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1.0 INTRODUCTION AND SUMMARY

1.1 Introduction

This report is the final version of the socio-economic impact assessment component of the Boston Harbor-Eastern Massachusetts Metropolitan Area (EMMA) Wastewater Management Study, prepared through the New England Division of the U.S. Army Corps of Engineers by Abt Associates Inc. under Contract No. DACW-74-C-0068. An earlier draft version of this report was reviewed by the Technical Subcommittee responsible for the overall study, and appropriate changes and additions were made to the draft based on the Subcommittee's recommendations.

The main body of the report is organized into nine substantive chapters, corresponding to specific requirements contained in the contract Scope of Work:

1. Socio-economic Conditions: Current and Projected;
2. Land Use;
3. Housing;
4. Industrial Activity;
5. Recreational Opportunity;
6. Commercial Activity;
7. Agriculture and Forestry;
8. Municipal Finance;
9. Employment and Income.

This format represents several departures from the original Scope of Work which should be noted. First, for analytical purposes, the two impact categories of Population and Housing were combined into a single category because of their closely related nature. Second, the impact category of Fish and Wildlife was dropped by mutual agreement with the Corps of Engineers as this area was being covered by another contractor. Third, in many cases it was not possible to distinguish usefully between short and long term impacts which would result from the proposed engineering concepts and thus these were discussed together under each substantive heading. Finally, given that no specific sites were ever identified for either treatment plants, interceptors or land application, it did not prove

feasible to identify and discuss short-term impacts in the required areas of educational opportunity, transportation, security and community image.

In most instances, site-specific land use conflicts being the principal exception, the analysis of socio-economic impacts in the EMMA Study Area was deliberately limited to those 59 communities where the proposed treatment solution differed across the five engineering concepts. Fifty other communities which would be served by peripheral systems which did not differ across concepts were not dealt with at any length. The basic rationale for this approach, agreed to by the Corps of Engineers, was to enable the study to focus on the differential impacts associated with the five engineering concepts at issue. The ultimate output of the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study was intended to be a choice among alternative engineering solutions, either in their present or some revised form. Therefore, the focus on just those communities where the engineers saw possible alternative solutions represented a pragmatic decision to allocate scarce analytic resources where the payoff in terms of input useful to decision-makers would be the greatest. Also as a practical matter, the option to perform analysis of the "without project" case was effectively foreclosed to Abt Associates at the outset of the study by the decision of Metcalf and Eddy and the Metropolitan Area Planning Council to limit their runs of the EMPIRIC activity allocation model to just those which assumed given sewerage and treatment needs.

A final section in this Introduction and Summary chapter has been added to reflect the subsequent recommendation of the Technical Subcommittee that a regional treatment plant be constructed at Wellesley. All of Abt Associates' judgements on the Mid-Charles plant are contained in this one section. The analysis in the principal substantive chapters remains limited to the initial set of five engineering concepts proposed at the beginning of the study.

1.2 Summary of Major Findings and Conclusions

Impacts of Treatment Facilities

1. **Because so many of the treatment plants proposed are common to all five engineering concepts, differential impacts on local**

land use are not substantial. Expectably, concepts 4 and 5, being the most decentralized, involve the greatest number of conflicts, while concept 3 causes the least conflict since it calls for the smallest number of plants to be constructed or expanded.

2. This very preliminary inspection of potential land use conflicts should be interpreted only as a first step suggesting where further investigation of suitable sites or site mitigation measures should be undertaken, rather than be used as a basis for evaluating the different concepts; it may well be that alternate sites could be found that avoid the conflicts identified, or that adequate site screening, for example, could be provided where adjacent land uses appear to be infringed upon.

Impacts of Land Application Sites

1. In general, the towns involved in concept 5 have a relatively abundant supply of vacant land capable of being developed with on-site sewage disposal systems, and these communities are not experiencing pressures for rapid development; consequently, future growth, including recreation needs, should not be constrained by allocation of the proposed acreages to effluent disposal.

2. The majority of selected disposal sites are quite remote from existing and planned development centers. Land affected that is now privately owned would be expected in most cases either to remain as open space or to develop only very gradually.

3. Potentially adverse impacts of major importance that will require further technical assessment before conclusions can be reached are: (a) possible contamination of existing aquifers

as the result of a large-scale application of incompletely treated effluent, and (b) possible damage to numerous cranberry bogs from nutrients contained in the effluent and potential drainage problems associated with the application of large volumes of effluent on nearby land.

Impacts of New Interceptors

1. With the exception of the Upper Charles and the Hopkinton-Marlborough-Southborough sub-areas, the proposed interceptors do not differ across concepts and thus do not lend to differential impacts.

2. In the Upper Charles River sub-area, the impact of the proposed interceptors is not expected to be great in terms of major land use changes. A large proportion of the areas proposed for sewering are already-developed older residential areas, and the demand for new industrial and commercial sites in the sub-area is not great. Gradual growth of population and residential acreage in the sub-area would be expected in any case since much of the sub-area is suitable for on-site sewage disposal. The principal exception seems to be Medfield, which generally has soils unsuitable for on-site disposal and which is projected to have the largest growth of any Town in the sub-region, 1970-1990, assuming development of future sewerage systems.

3. The Towns in the Upper Charles sub-area have extensive swamps and wetlands from which the headwaters of the River arise. Some of the areas proposed for future sewerage appear to encroach on these wetlands.

4. In addition, gradual development of the Upper Charles River Basin, regardless of sewer interceptors, will significantly reduce forested acreage in this sub-area, with potential effects upon run-off into the Charles.

5. Location of the interceptors along the Charles River (to different degrees under different Concept plans) will tend to encourage higher intensity uses to concentrate in this corridor.
6. Relative to the Upper Charles sub-area, the Hopkinton-Marlborough-Southborough sub-area is in a more rapidly growing part of the State. Expanding sewer capacity here therefore has a much greater potential for "triggering" further development. Ashland and Framingham are expected to grow rapidly in the 1970-90 period. However, these communities are already tied into the existing MDC system, so the impact of the proposed new interceptors will be limited to concentrating this potential growth in the interceptor corridors. The greatest potential change attributable directly to the proposed new interceptors could come in Hopkinton, which had no existing system in 1970.
7. A number of "external" impacts have also been identified, including continued enhancement of downstream riverbanks for future development as the "clean-up" of the river continues; the probable continued trend toward lower densities in the core area as the concomitant of further suburban growth; and the possibilities of "opportunities foregone" as the result of the adoption of any of the proposed Concept plans.

<u>Housing</u>

1. In relative unsewered areas which lie in rapid growth corridors, such as Westborough and Hopkinton, the potential impact upon residential growth can be large. The new interceptors could exercise a "triggering" effect upon future residential development. The same effect can occur in Marlborough and Framingham as capacity is upgraded, even though these communities already have substantial systems.

2. In an area experiencing less rapid growth, the Upper Charles River sub-area, sewering will upgrade the quality of existing residential areas and contribute to improved community health over the long run, but will have less of an effect upon triggering growth. (Much of the expected growth in this area is attributable to one-family units with on-site sewage disposal.)
3. Local zoning and other policies will have a greater influence with regard to growth, new construction, and low-and-moderate income housing than presence or absence of sewer interceptors per se. However, availability of sewerage will probably mitigate to some extent the weight of this reason for not constructing new low and moderate income housing.
4. In the long term, extension of sewer interceptors tends to make suburban areas more suitable for continued residential development. The causality of this relationship also operates in the other direction, however; i.e., continuing residential development in suburban areas eventually results in population and political strength in these areas which in turn can increase the probability that sewers will be built. Each proposed extension is therefore only one step in a continuing process of incremental development.

Industrial Activity

1. Five industry categories in the EMMA study area will bear the major burden of industrial costs associated with implementing any of the five proposed engineering concepts: paper, metals, chemicals, textiles, and food processing. Major discharges (more than 50KGD) in these categories currently account for 55,500 jobs.
2. Estimated percentage increases in product prices which would be attributable to added treatment costs in these industry categories are relatively low (less than 1%), except for paper products where it could be as high as 8.6%.

3. The resulting estimate of the maximum number of 1977 jobs which would be lost because of the additional costs of wastewater treatment to these industries is also low, 155 jobs.
4. Given the roughly comparable total costs of the five engineering concepts, the analysis cannot usefully discriminate among them regarding industrial job losses. If a preference ordering is called for, the only reasonable one would be one based on total costs.

Recreation

1. Impacts on recreational opportunity associated with the five proposed engineering concepts will be largely the result of (a) changes in water quality and (b) acquisition of land for waste treatment and disposal sites.

2. Certain positive water-oriented recreation impacts will result from implementation of any one of the five concepts, either because of common elements contained in them or separate actions independently planned. These will occur in Boston Harbor, the North and South coastal areas, and in the Assabet and Concord River basins.

3. Between the two centralized water-oriented concepts (1,3), on balance concept 1 should be preferred on recreational grounds because of positive water quality impacts in the Upper Charles basin.

4. Between concept 4 and the water-oriented portion of concept 5, the latter configuration should be preferred on recreation grounds because of its avoidance of negative water quality impacts in the Sudbury River basin.

5. The basic recreational trade-off between the two water-oriented decentralized concepts (2,4) involves differential impacts in the Mystic and Neponset River basins. The strongly positive impact of concept 4 on water quality in the Aberjona River would, on balance, appear to make concept 4 preferable from the standpoint of recreational opportunity (subject to item 4 above).

6. Proposed treatment plant sites at Medford (concepts 4,5), North Canton (concept 2) and Sudbury (all five concepts) conflict directly with existing recreational open space uses.

7. Taking of land for land application sites in southeastern Massachusetts under concept 5 could have a major negative impact on recreation opportunity, the major unknown being the effect of spray irrigation in Myles Standish and Freetown-Fall River State Forests on public attitudes toward use of these recreational facilities.

Commercial Activity

1. The major commercial activities which potentially will be affected by the proposed engineering alternatives are shell fishing and recreation-related supply and support businesses.

2. No data are available to support detailed analysis of the impact of uncertain water quality changes on the demand for recreation-related commercial services. The only reasonable conclusion would be that such businesses will gain from improvements in EMMA area water quality, in some general bit of unspecified manner.

3. The most serious pollution of coastal waters (not including Boston Inner Harbor) comes from towns which currently discharge raw sewage directly into the ocean, such as Gloucester, Essex and Hull. Changeover to secondary treatment in these towns will result in a substantial decrease in concentrations of hazardous substances and thus to a decreased health hazard to shellfish areas.

4. Proposed improvements in collection systems in those faster-growing towns adjacent to North and South Shore shellfishing areas should reinforce the anticipated improvements in coastal water quality and help prevent future contamination.

5. The economic value to commercial fisheries of pollution reduction cannot be estimated precisely due to lack of current data. Anticipated water quality changes may or may not lead to lifting of existing public health restrictions on harvesting. Furthermore, the extent to which the potential benefit may be realizable will depend on market factors such as possible existing over-supply on the one hand and rising prices of competitive food products on the other.

Agriculture and Forestry

1. Concept 5 is the only one of the proposed engineering options which could lead to appreciable impact on agriculture.

2. The combined impact of the nitrogen "subsidy" involved in spray irrigation and the resulting increase in the productivity of the affected land for forage crops could have a market value of approximately $1.6 million to private farmers.

3. A secondary impact of spray irrigation, as yet of unknown dimensions, could be to adversely affect cranberry growing areas near proposed application sites.

4. It is not possible to place an economic value on the potential impact of spray irrigation of secondarily treated effluent on forested lands in southeastern Massachusetts because of the inconclusive nature of the scientific evidence available.

Municipal Finance

1. The total capital costs of the four water-oriented concepts are roughly comparable, the spread from lowest (Concept 1) to highest (Concept 4) being only $99 million, or 14%.

2. The projected impacts of capital costs on current property tax rates are nominal across all five concepts. The average tax rate increase associated with the highest cost concept is still less than 1%.

3. Annual operations and maintenance costs are essentially the same for the two centralized concepts (1, 3) and the land disposal option (5). The two decentralized concepts (2,4) are both more than twice as expensive for O&M as these first three.

4. The impacts of annual O&M costs will be substantial under all five concepts, and will represent a heavy additional burden for individual communities. For concept 3, which has the lowest annual O&M costs, the average increase in the O&M assessment for the 41 current MSD member communities over that for FY 1973 would be 108%. Under the concept with the highest annual O&M costs, concept 4, this average increase over FY 1973 jumps to 453%.

5. Allocating the full costs of satellite plants to just the communities they directly serve would unfairly burden these communities by ignoring the dollar value of their previous investments in Deer and Nut Islands. Furthermore, this approach would lead to ruinous increases in annual O&M assessments for satellite communities, on the order of 700 to 1200%.

6. From a least-cost standpoint appropriate to municipal finance, concept 1 is the preferred engineering solution. It combines capital and O&M cost savings to the greatest extent attainable under the five concepts proposed.

7. Next most preferred are concepts 3 and 5. They entail capital expenditures $94 million higher than concept 2, but the differential impact on tax rates is nominal while the annual O&M cost savings over concept 2 are substantial. As between concepts 3 and 5, concept 3 is preferred on the basis of a slightly greater O&M cost saving.

8. The two decentralized concepts (2,4) are the most expensive and hence the least preferred. Of these two, concept 2 is preferable to concept 4 on the basis of overall costs.

9. The MDC should be enabled to continue allocating annual capital and O&M costs to its member communities on a region-wide basis rather than at the individual facility level.

Employment and Income

1. The proposed engineering concepts can potentially affect income and employment through a variety of channels, including construction jobs, plant O&M employment, industrial jobs, recreation-based commercial employment, agricultural income, and municipal taxes.

2. No clear pattern regarding an overall preference ordering among the five concepts can be detected by examining these individual partial impacts. The decentralized options maximize the direct employment benefits. The centralized options minimize the fiscal impact on local taxes and hence, personal incomes. Other impacts, with the exception of agricultural

income, either do not discriminate among options or rest on such shaky data as to be of doubtful utility for making choices.

3. On balance, the impacts on municipal finance would appear to be relatively the strongest as they affect income and thus Concepts 1 and 3 are preferred, followed by Concepts 5, 2 and then 4.

1.3 Qualitative Ranking of Engineering Concepts

Consistent with the approach taken by the engineering and other impact assessment contractors associated with the EMMA Wastewater Management Study, this section presents an overall qualitative rating of the five engineering concepts based on their impacts in the individual assessment categories. These ratings are summarized below in Table 1.1.

Table 1.1
Qualitative Ranking of Concepts

	Concepts				
	1	2	3	4	5
Land Use	2	3	1	4	5
Population and Housing	[		NO DIFFERENCE		]
Industrial Activity	1	4	2	5	3
Recreational Opportunity	1	4	5	3	2
Commercial Activity	1	4	5	3	2
Agriculture and Forestry	[		NO DIFFERENCE	]	1
Municipal Finance and Services	1	4	2	5	3
Employment and Income	1	4	2	5	3

The ranking on Land Use is based on the number of instances where a proposed treatment plant site conflicts with an existing or planned use. Clearly, the selection of this measure for ranking purposes tends to favor centralized over decentralized options because of the smaller number of treatment plants proposed. Land use issues involving either proposed land application sites or new interceptors simply did not provide any bases for preferring one concept over another.

The "no difference" ranking on Population and Housing simply reflects the fact that, with two exceptions, planned interceptor corridors do not differ across concepts.

Since the major industrial impacts will come from increased costs due to industrial cost recovery, pretreatment, and the industrial shares of construction and O&M costs, the ranking here is based on minimizing the combined impact of the construction and O&M costs, as developed by the engineering contractors. This does not mean that concepts are ranked by total costs. Concept 3 costs more than Concept 2, but because of the differences in funding arrangements regarding construction and O&M the cost impact of Concept 3 is less than that of Concept 2.

The ranking for Recreational Opportunity is based on a conservative approach which minimizes the number of unfavorable impacts on stream water quality due to the individual concepts. Under this approach, a preponderance of "no effects" is preferable to one or two strongly positive impacts associated with a similar or greater number of negative impacts.

Commercial Activity impacts are next to impossible to differentiate across concepts. This was certainly true with commercial shell fishing. The ranking shown here is keyed to recreation-related supply and support activities, which in turn are assumed to be directly related to the differential impacts on recreational opportunity.

Concept 5 is the only one of the proposed engineering options which would have any demonstrable impact on Agriculture. It would lead to an increase in gross farm income due to increased production of forage crops on lands affected by spray irrigation. No differential impacts on forest land could be identified.

Similar to the situation for industrial discharges, the major impact on Municipal Finance and Services will come from the combined impact of the construction and O&M cost burden on local municipal budgets. Accordingly, the concepts are again ranked so as to minimize this combined construction and O&M cost impact.

Finally, the overall impact on Income and Employment is necessarily an accumulation of related partial impacts on industrial employment, commercial jobs, farm income, and personal and corporate taxes. Since the impact on personal and corporate taxes was by far the most sizeable and easily differentiable across concepts, this category was ranked like Industrial Activity and Municipal Finance, on the basis of combined construction and O&M costs.

1.4 Middle Charles Area Treatment Plant

Subsequent to the main analysis performed by Abt Associates as a part of this study, the Technical Sub-Committee for the Boston Harbor-Eastern Massachusetts Metropolitan Area Study has recommended adoption of a modified version of concept 1, which would include an advanced treatment plant in the Middle Charles Area. This section briefly discusses the modified concept as an alternative to the five engineering concepts originally put forward.

The capital cost of the modified plan would be $735 million, which would make it slightly more expensive than concepts 1 and 2 but still less than 3, 4 or 5. The capital cost differences, however, are small to begin with and when federal and state construction subsidies are taken into account, the differences in the annual cost of the local share across all the concepts are minimal. The modified concept involving the Mid-Charles plant will cost $650,000 more a year in debt service than the least cost concept.

Annual operation and maintenance costs for the modified concept would be $29 million. This would represent a considerable annual cost saving over either of the other decentralized approaches, concepts 2 and 4, where operation and maintenance costs would be $39 million and $47 million respectively. Since operation and maintenance costs are borne entirely at the local level, this aspect would definitely make the modified concept more attractive than concepts 2 and 4 given that some degree of decentralization is desirable on non-cost grounds.

The additional flows of clean water (30 MGD) to the Charles River represented by the proposed plant will be extremely important to maintaining water quality in that basin during dry periods. The principal

recreation benefit will be to boaters and canoeists in terms of sufficient flows to enable them to enjoy use of the river at these times. Without the augmented flow, there would likely be extensive development of marsh into the present river channel thereby obstructing boat passage through what is otherwise a fairly attractive reach.

In summary, concept 1 as modified by the Technical Sub-Committee achieves the benefits of limited decentralization at about the same local capital cost but at significantly lower annual operation and maintenance costs than either of the initial decentralized options. It provides for increased flows in a stretch of the Charles River threatened by perennial low flow conditions and, as distinguished from concepts 2 and 4 which both involved a plant further downstream on the Charles at Dedham, it affords better opportunities for reaeration than do downstream reaches.

2.0 SOCIO-ECONOMIC CONDITIONS: CURRENT AND PROJECTED

The purpose of this chapter is to provide a brief description of current and projected socio-economic conditions in the Eastern Massachusetts Metropolitan Area (EMMA) as they relate to water quality management. The map which appears on the following page outlines the boundaries of the EMMA Study Area; for ease of presentation of data it further distinguishes among the Boston "core" area, the inner suburbs and the outer suburbs. Data is provided on population, employment, income, land use and recreation. This chapter is not intended to be exhaustive on these subjects, but merely to establish the needed baseline for the analytic chapters which follow. For a more detailed description and projection of socio-economic conditions in the EMMA area, the reader is referred to the 1973 Planning Study prepared jointly by Metcalf and Eddy and the Metropolitan Area Planning Council.

2.1 Population

Table 2.1 below illustrates the basic demographic changes which took place in the EMMA Study area over the decade of the 1960's. The pattern was one of population loss in the Boston core area accompanied by moderate growth on the ring of close-in, already well-developed suburbs and dramatic gains in the outlying suburban areas. This pattern is consistent with national trends and was re-inforced in part by major circumferential highway development in the area which made suburban areas more accessible to Boston.

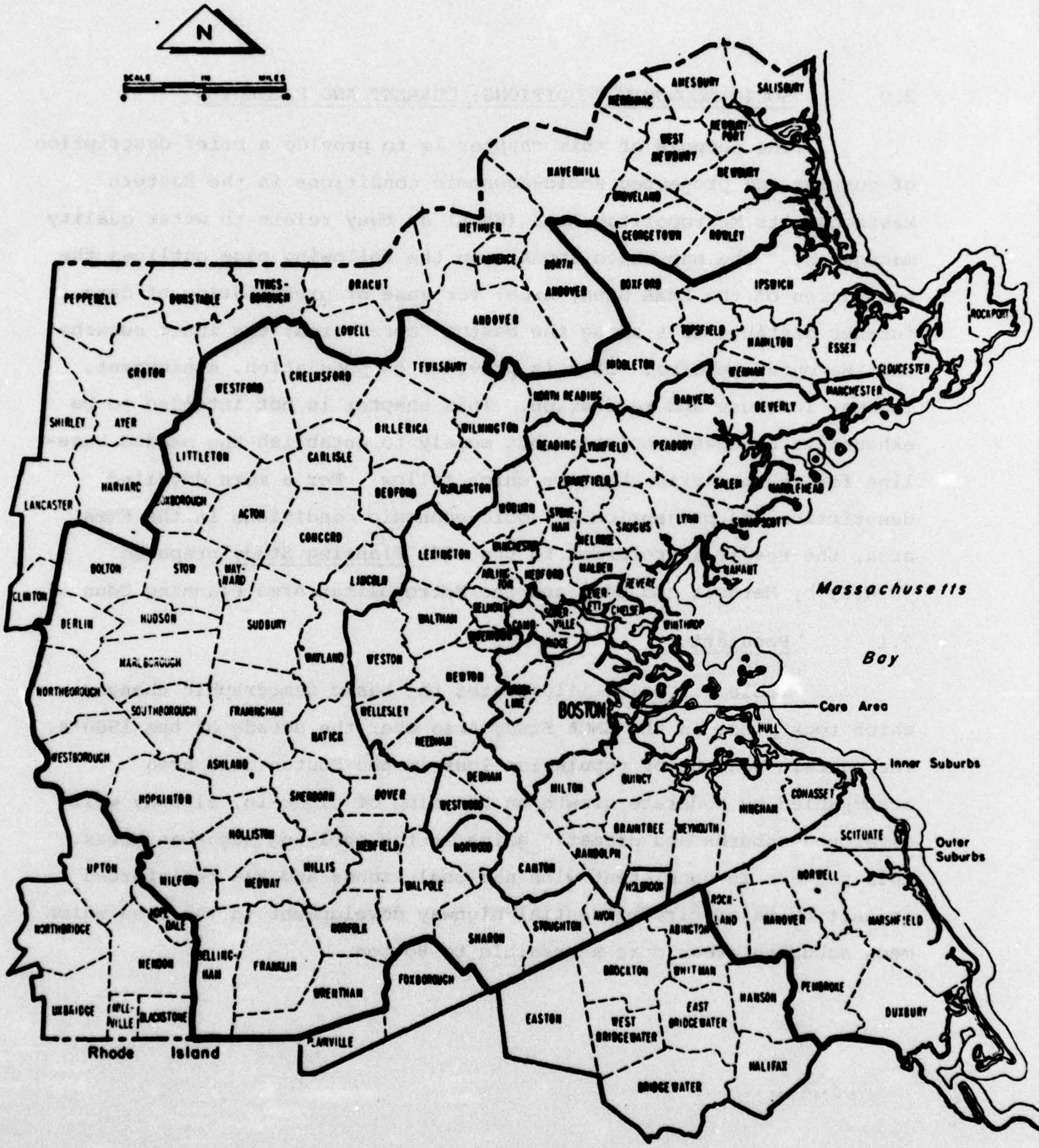

FIG. 5-1

MDC Study Area

CORE AREA

INNER AND OUTER SUBURBS

Metcalf & Eddy, Inc. Engineers & Planners

Boston, Mass.

TABLE 2.1

1960-1970 POPULATION CHANGES

	Population	% Change
EMMA Study Area Totals		
1960	2,847,943	
1970	3,129,228	+ 9.9
Core Area		
1960	1,031,744	
1970	961,476	- 6.8
Inner Suburbs		
1960	1,257,879	
1970	1,368,467	+ 8.8
Outer Suburbs		
1960	558,320	
1970	799,285	+43.2

Source: Metcalf and Eddy Planning Study
Appendix L

Table 2.2 shows the Metcalf and Eddy projections for population growth and distribution in the Study Area for three points in the future, the years 1990, 2020 and 2050. For at least the 1970-1990 period, current trends are projected to continue. The overall population increase will be around 15%, with the core area continuing to lose population to the inner and especially the outer suburbs. Over the longer run the core and inner suburban areas are expected to stabilize at slightly higher levels, while the outer suburbs catch up with and then outstrip the inner suburbs as the dominant area.

TABLE 2.2

1970 - 2050 POPULATION PROJECTIONS

	1970	1990		2020		2050	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
EMMA Study Area Totals	3,129,228	3,631,303	3,500,965	4,455,688	3,936,803	5,133,908	3,997,819
Core Area	961,476	883,885	871,934	935,847	835,224	957,739	798,959
Inner Suburbs	1,368,467	1,576,283	1,515,709	1,781,984	1,593,332	1,807,741	1,492,246
Outer Suburbs	799,285	1,171,162	1,113,363	1,737,883	1,508,274	2,368,457	1,706,644

Source: Metcalf and Eddy Planning Study
Appendix L

2.2 Employment

The entire Eastern Massachusetts Metropolitan Area is in the midst of a transition from primarily a manufacturing to a service-oriented economy. Table 2.3 shows the dimensions of the employment shifts which took place over the decade of the 1960's. For maximum relevance to water quality concerns, the employment categories used are based on water use characteristics. Dry, Wet and Very Wet manufacturing relates to specific 2-digit SIC categories which require little, moderate, or heavy use of process water, respectively; Industrial Non-Manufacturing includes agriculture, construction, transportation, communications, utilities and wholesale trade, while Commercial covers retail trade, finance, insurance, real estate, services and government. Moderate declines in manufacturing jobs are accompanied by large increases in non-manufacturing and commercial employment, leading to an overall increase in employment over the decade of roughly 25%. The declines were concentrated in non-durable goods industries such as apparel, leather and paper products. Lesser declines also occurred in the durable goods sector, especially in machinery and electrical machinery. Employment growth in the Study Area was led by insurance, medical services, private education, business services and tourism. Instruments led the growth among the non-manufacturing industrial categories.

Regarding spatial distribution of employment changes, between 1947 and 1970 the City of Boston lost roughly one-half of its total manufacturing jobs. Over this same time period, the EMMA Study Area as a whole lost only 5% of its manufacturing jobs. The decade of the 1960's continued the already existing trend of industry relocation to suburban areas.

Again, the Metcalf and Eddy projection regarding area employment growth show a continuation of these trends into the forecastable future. Table 2.4 below shows employment projections for the EMMA Study Area for 1990, 2020 and 2050. Continuing declines in the manufacturing categories will occur along with sizable growth in both the non-manufacturing and commercial categories.

TABLE 2.3

EMPLOYMENT CHANGES 1960 - 1970

	1960	1970	% Change
Dry Manufacturing	238,942	223,649	- 6.4
Wet Manufacturing	81,384	75,865	- 6.8
Very Wet Manufacturing	3,652	2,503	- 31.4
Non-Manufacturing Industry	249,694	316,983	+ 26.9
Commercial	530,006	770,385	+ 45.4
EMMA Study Area Totals	1,104,000	1,389,000	+ 25.8

Source: Metcalf and Eddy Planning Study
Appendix L

TABLE 2.4

1970 - 2050 EMPLOYMENT PROJECTIONS

	1970	1990		2020		2050	
		HIGH	LOW	HIGH	LOW	HIGH	LOW
Dry Manufacturing	238,942	210,001	165,001	195,001	150,001	180,003	135,001
Wet Manufacturing	81,384	65,000	53,000	50,001	38,000	35,000	13,021
Very Wet Manufacturing	3,652	1,500	1,500	1,000	1,000	1,000	1,000
Non-Manufacturing Industry	249,694	425,000	400,000	480,005	475,001	575,500	565,000
Commercial	530,006	950,001	900,000	1,200,013	1,075,000	1,550,006	1,320,003
EMMA Study Area Totals	1,104,000	1,651,496	1,519,496	1,926,006	1,738,993	2,341,497	2,034,007

Source: Metcalf and Eddy Planning Study
Appendix L

According to the Metcalf and Eddy study the factors expected to negatively influence economic growth in the Study Area are:[1]

1. Fuel costs are 10 to 20 percent above the national average.
2. Electrical power costs are 10% above the national average.
3. Massachusetts is barren of natural resources.
4. Very little good farmland exists in the state.
5. Locations are not well suited for distribution to national markets.
6. Unskilled labor is more expensive relative to the other parts of the country.
7. The cost of living is well above the national average.
8. High state and local taxes are prevalent.
9. Low expenditure for public education.

Also, certain other economic and political assumptions are built into the Metcalf and Eddy projections:

1. The Study Area's output will grow at a slower rate than that for the nation. The period from 1970 to 1990 will be one of relatively slow growth in employment.
2. Reductions related to defense will decrease employment.
3. Insurance, medical services, private education and business services will continue to be the most important non-manufacturing export industries.
4. Employment in manufacturing will decrease between 1970 and 1980, especially in paper, leather and electrical machinery.
5. Finance, real estate, business and professional services will experience rapid growth. Tourism will increase.
6. The anticipated growth in labor supply will be more than adequate to meet the increased demand for white collar workers.
7. Federal research programs will not increase substantially in the Study Area.

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[1]Eastern Massachusetts Metropolitan Area Water Quality Control Project, Draft Report on Planning, Metcalf and Eddy, October 1973, pp 3-24 and 3-25

8. Environmental protection requirements will have a negative effect on manufacturing.

9. The energy crisis will have a negative effect on the Study Area.

2.3 Personal Income

Distribution of households by income within the EMMA Study Area follow a distinct if common pattern.[1] Table 2.5 shows that as of 1970 one-half of low income households (0-15 percentile) was located within the Boston core area. Lower middle income households (15-55 percentile) are distributed roughly one-third/two-thirds between the core and suburban areas. Upper middle (55-80 percentile) and high income households (80-100 percentile) both show a one-fourth/three fourths split between the core and the suburban areas. Over the decade of the 1960's their pattern was re-inforced by sizeable movements of lower middle, upper middle and high income families out of the Boston core into the suburbs.

Study Area projections for 1990 indicate that all four income groups will tend to decline in number in the Boston core area, with most of the movement being to the outer suburbs where development is still possible.[2]

2.4 Land Use

An important factor influencing both the location of future development and the future tax burdens on individual municipalities will be the extent of public sewering. As the basis for developing the five engineering concepts Metcalf and Eddy projected sewered acreage for each EMMA Study Area community drawing on MAPC's 1969 study Projected Needs and Current Proposals for Water and Sewer Facilities. These projections are shown in Table 2.6 on the following pages. They are expressed for convenience in terms of percentage of total acres sewered. Clearly, most communities in the EMMA Study Area will be going to full sewering by 2050, most of them earlier. In the suburban areas, particularly in the outer ring, this will mean increased pressure on "developable" land and increased taxes to pay for the costs of servicing. Currently sewer construction costs are paid for 100% by the local community.

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[1] Ibid., p. 4-6

[2] Ibid., Appendix L

TABLE 2.5

1960 - 1970 INCOME DATA

EMMA STUDY AREA

	LOW INCOME HOUSEHOLDS		LOWER MIDDLE INCOME HOUSEHOLDS		UPPER MIDDLE INCOME HOUSEHOLDS		HIGH INCOME HOUSEHOLDS	
	NO.	% EMMA TOTAL	NO.	% EMMA TOTAL	NO.	% EMMA TOTAL	NO.	% EMMA TOTAL
EMMA Study Area Totals								
1960	126,275	-	336,738	-	210,460	-	168,369	-
1970	142,305	-	379.482	-	237,176	-	189,740	-
Core Area								
1960	64,831	51.3	143,307	42.6	70,932	33.7	50,433	30.0
1970	71,934	50.5	137,864	36.3	57.423	24.2	44,368	23.4
Inner Suburbs								
1960	44,792	35.5	133,324	39.6	96.736	46.0	86,845	51.2
1970	49,029	34.5	159,219	42.0	112,912	47.6	95,490	50.3
Outer Suburbs								
1960	16,654	13.2	60,009	17.8	42,793	20.3	31.093	18.5
1970	21,344	15.0	82,400	21.7	66,843	28.2	49,883	26.3

Source: Metcalf and Eddy Planning Study, Appendix L

TABLE 2.6

PERCENT OF LAND AREA WITH PUBLIC SEWERS AVAILABLE TO DEVELOPMENT

MDC - PMR TOWN CODES			1970 %	1990 %	2020 %	2050 %	Total Acres	1970 Developable Acres (Used Acres and Vacant Acres)
0	001	Acton	0	65	100	100	12,998	10,993
1	002	Arlington	100	100	100	100	3,571	2,286
2	003	Ashland	3	70	100	100	8,294	6,661
0	004	Avon	0	70	100	100	2,880	1,970
1	005	Bedford	38	70	100	100	8,864	4,778
0	006	Bellingham	0	30	75	100	12,070	6,185
1	007	Belmont	100	100	100	100	2,982	2,141
0	008	Berlin	0	25	70	100	8,435	7,772
2	009	Beverly	36	76	100	100	9,830	7,386
0	010	Billerica	2	50	100	100	16,614	13,615
0	011	Bolton	0	0	50	100	12,794	11,716
		Boston*						
2	012	Boxborough	0	20	50	100	6,656	5,868
0	013	Boxford	0	0	50	100	15,610	13,025
2	014	Braintree	93	95	100	100	9,222	6,202
1	015	Brookline (D)	100	100	100	100	1,091	776
2	016	Brookline (N)	100	100	100	100	3,274	2,478
1	017	Burlington	25	100	100	100	7,603	5,766
1	018	Cambridge	100	100	100	100	4,570	2,589
2	019	Canton	27	75	100	100	12,403	8,287
0	020	Carlisle	0				9,882	8,687
0	021	Chelmsford	3	35	100	100	14,694	11,478
1	022	Chelsea	100	100	100	100	1,309	866
2	023	Cohasset	1	35	80	80	6,438	4,256
2	024	Concord	6	20	80	100	16,492	13,379
2	025	Danvers	41	96	100	100	8,858	[illegible]

	AVAILABILITY OF PUBLIC SEWERS	MDC - PMM		1970 %	1990 %	2020 %	2050 %	Total Acres	1970 Developable Acres (Used Acres and Vacant Acres)
	2	026	Dedham	80	100	100	100	6,906	4,352
	0	027	Dover	0	0			9,798	9,062
	0	028	Duxbury	0	0			15,686	11,777
	[illegible]	029	Essex	0	20	70	100	9,203	5,593
	1	030	Everett	100	100	100	100	2,400	1,365
	2	031	Framingham	78	90	100	100	17,453	13,506
	0	032	Franklin	9	22	80	100	17,280	6,876
	0	033	Gloucester	9	25	80	100	16,928	12,225
	0	034	Hamilton	0	15	70	100	9,594	7,289
	0	035	Hanover	0	100	100	100	10,003	8,293
S	2	036	Hingham	13	50	85	85	14,458	7,479
	2	037	Holbrook	0	70	100	100	4,685	3,821
	0	038	Holliston	0	25	80	100	12,224	9,885
	0	039	Hopkinton	0	40	80	100	17,869	5,968
	[illegible]	040	Hudson	60	10	100	100	7,558	6,375
S	0	041	Hull	37	90	90	90	1,619	972
S	0	042	Ipswich	2	22	50	70	21,344	10,494
	1	043	Lexington	74	90	100	100	10,643	8,510
	0	044	Lincoln	2	2			9,549	8,018
	0	045	Littleton	0	18	80	100	11,098	8,847
S	0	046	Lynn	90	90	90	90	7,174	3,872
	0	047	Lynnfield	0	25	100	100	6,714	4,299
	1	048	Malden	100	100	100	100	3,283	2,178
	0	049	Manchester	14	42	100	100	4,941	3,978
	0	050	Marblehead	96	100	100	100	2,829	1,815
	0	051	Marlborough	22	48	100	100	24,1[illegible]	11,773
	0	052	Marshfield	1	28	80	100	18,253	12,782
	0	053	Maynard	36	50	80	100	3,424	2,623
	0	054	Medfield	3	55	100	100	9,293	7,03[illegible]

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AVAILABILITY OF PUBLIC SEWERS MDC - PKS				1970 %	1990 %	2020 %	2050 %	Total Acres	1970 Developable Acres (Used Acres and Vacant Acres)
	1	055	Medford	85	85	85	85	5,606	2,764
	C	056	Medway	2	35	90	100	7,462	6,494
	1	057	Melrose	96	100	100	100	3,072	1,787
	C	058	Middleton	0	15	70	100	[illegible]	[illegible]
	0	059	Milford	32	35	100	100	9,594	4,[illegible]46
	0	060	Millis	6	55	100	100	7,846	6,3[illegible]0
	1	061	Milton (D)	100	100	100	100	422	340
S	2	062	Milton (M)	56	65	65	65	8,026	4,388
	0	063	Nahant	100	100	100	100	678	431
	2	064	Natick	36	70	100	100	10,234	7,[illegible]34
	2	065	Needham	68	78	100	100	8,160	5,695
	1	066	Newton (D)	100	100	100	100	4,106	2,6[illegible]9
	2	067	Newton (N)	100	100	100	100	7,625	5,[illegible]44
	0	068	Norfolk	0	0			9,824	8,464
	0	069	North Reading	0	50	100	100	8,659	6,848
	0	070	Northborough	0	45	100	100	11,981	10,379
	0	071	Norwell	0	0			13,651	9,433
	2	072	Norwood	100	100	100	100	6,778	4,381
	0	073	Peabody	34	92	100	100	10,758	7,588
	0	074	Pembroke	0	20	50	100	14,886	11,474
S	2	075	Quincy	71	75	75	75	10,650	4,875
	2	076	Randolph	37	90	100	100	6,605	3,839
	1	077	Reading	34	75	100	100	6,304	3,934
S	1	078	Revere	80	80	80	80	4,045	1,990
	0	079	Rockland	22	90	100	100	6,470	4,217
	0	080	Rockport	11	65	100	100	4,531	3,601
	0	081	Salem	54	75	80	80	5,235	2,309
S	[illegible]	082	Saugus	30	70	70	70	7,411	4,0[illegible]8
	0	[illegible]3	Scituate	20	60	100	100	10,925	7,[illegible]

	AVAILABILITY OF PUBLIC SEWERS PACT	MDC		1970 %	1990 %	2020 %	2050 %	Total Acres	1970 Developable Acres (Used Acres and Vacant Acres)
	0	084	Sharon	0	20	80	100	15,558	12,819
	0	085	Sherborn	0	0			9,850	8,356
	1	086	Somerville	100	100	100	100	2,637	1,601
	0	087	Southborough	0	30	100	100	9,009	8,050
S	1	088	Stoneham	55	61	61	61	4,262	2,277
	2	089	Stoughton	28	75	100	100	10,490	8,412
	0	090	Stow	0	0			11,482	8,127
S	0	091	Sudbury	0	35	90	90	15,680	12,304
	0	092	Swampscott	85	100	100	100	1,984	1,316
	0	093	Tewksbury	0	60	100	100	13,382	10,415
	0	094	Topsfield	0	12	70	100	8,230	5,878
	1	095	Wakefield	95	100	100	100	5,050	3,455
	2	096	Walpole	12	65	100	100	13,498	11,145
	1	097	Waltham	95	100	100	100	8,553	5,451
	1	098	Watertown	100	100	100	100	2,669	1,570
	0	099	Wayland	0	65	100	100	10,163	7,674
	2	100	Wellesley	85	100	100	100	6,726	4,901
	0	101	Wenham	0	0			5,254	3,305
	0	102	Westborough	7	55	100	100	13,766	10,956
	0	103	Westford	0	10	100	100	19,840	16,613
	0	104	Weston	0	55	100	100	11,110	8,431
	2	105	Westwood	22	92	100	100	7,194	5,142
	2	106	Weymouth	90	90	100	100	11,341	7,439
	[illegible]	107	Wilmington	2	65	100	100	10,957	8,796
	[illegible]	108	Winchester	100	100	100	100	4,019	2,442
	1	109	Winthrop	100	100	100	100	1,043	527
	[illegible]	110	Woburn	45	100	100	100	8,390	5,800
	[illegible]	111	Wrentham	0	22	80	100	14,515	12,657

		AVAILABILITY OF PUBLIC SEWERS Boston Neighborhoods	1970 %	1990 %	2020 %	2050 %	Total Acres	1970 Developable Acres (Used Acres and Vacant Acres)
	1	112 Boston Proper	100	100	100	100	2,099	992
	1	113 Brighton	100	100	100	100	2,887	1,797
	1	114 Charlestown	100	100	100	100	1,071	618
	1	115 Dorchester (D)	100	100	100	100	4,296	2,519
S	2	116 Dorchester (N)	50	50	50	50	1,387	533
	1	117 East Boston	100	100	100	100	3,689	1,230
	1	118 Fenway - Jamaica (D)	100	100	100	100	1,944	1,118
S	2	119 Fenway - Jamaica (N)	60	60	60	60	625	353
S	2	120 Hyde Park	80	80	80	80	1,940	1,300
	2	121 Mattapan	100	100	100	100	1,076	765
S	2	122 Roslindale	90	90	90	90	1,732	1,058
	1	123 Roxbury	100	100	100	100	1,139	994
	1	124 South Boston	100	100	100	100	15,333	1,302
	2	125 West Roxbury	100	100	100	100	2,400	1,462
		SUBTOTAL						
		TOTAL						

S - at least 10 percent of land area is restricted open space.

SOURCE: METCALF AND EDDY PLANNING STUDY APPENDIX D

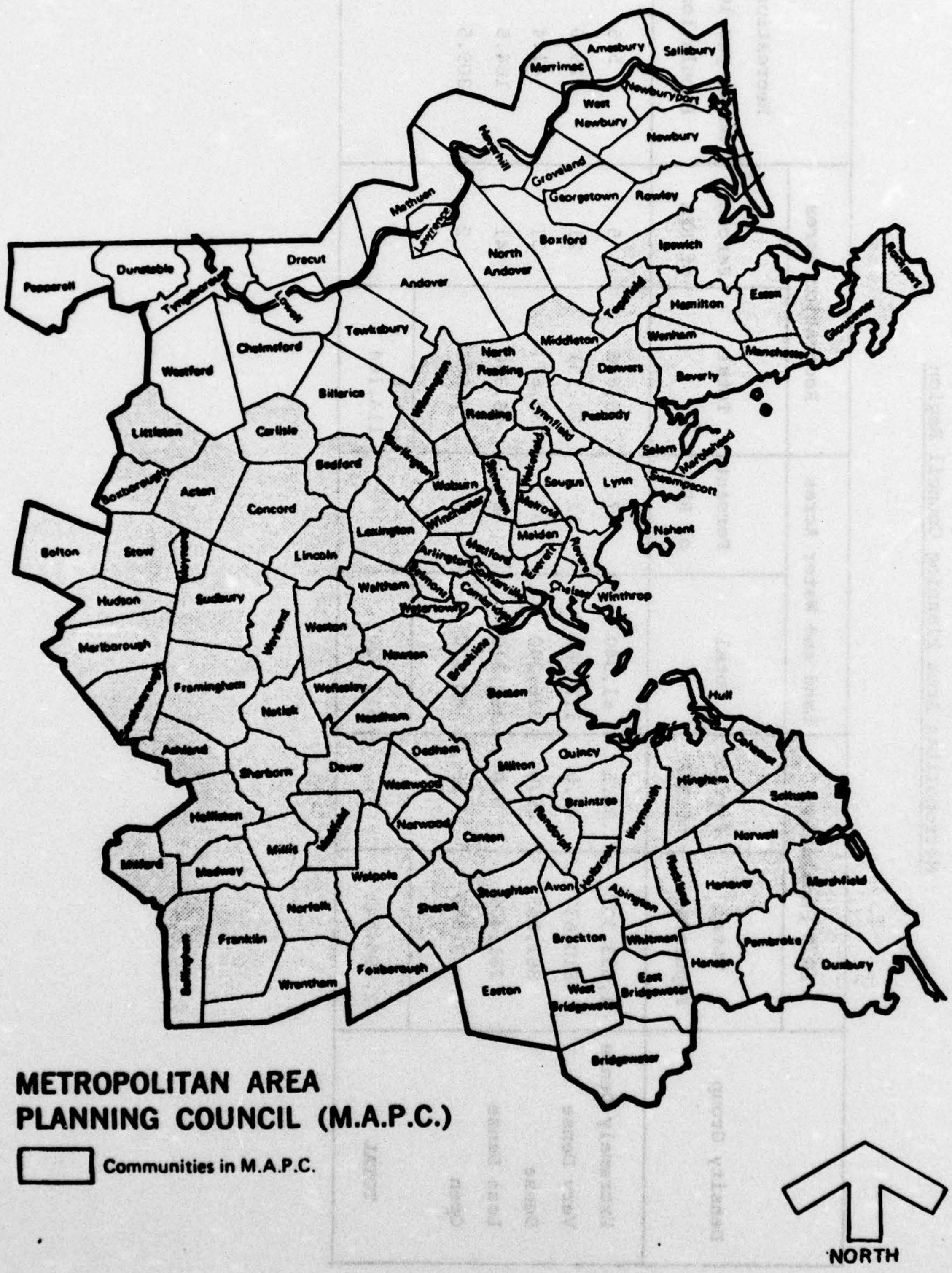
2.5 Recreation

Although they are not coterminous, the boundaries established for the EMMA Study Area roughly parallel those of the Metropolitan Area Planning Council (see map on the following page). The discussion of recreation activity, actual and potential, is specific to the MAPC area and draws heavily on the Eastern Massachusetts Supplement to the 1972 Massachusetts Outdoor Recreation Plan. One of the primary benefits anticipated from cleaner water is enhanced recreational opportunity. This section briefly describes the existing recreation situation in the Study Area for baseline purposes.

The 1970 Inventory (see Table 2.7) identified 114,164 recreation and open-space acres in the MAPC Region. The existing recreation acres in the MAPC Region represent 78% of the recreation acres in the Eastern Massachusetts Study Area. The major sites are owned by the Massachusetts Department of Natural Resources (DNR), the Metropolitan District Commission (MDC), the U.S. Department of the Interior and two private organizations - the Trustees of Reservations and the Massachusetts Audubon Society.

Wompatuck State Park, which contains 2,877 acres, is located in Cohasset, Hingham, Norwell and Scituate, and is the largest of the state-owned parks in the MAPC region. This park has facilities for fishing and hunting as well as trails for hiking and snowmobiling. There are also 450 campsites now under construction. Cochituate State Park, in Framingham, Natick and Wayland, offers a variety of facilities for such activities as swimming, boating, picnicking and fishing. Another large area of historic interest and recreation value is Walden Pond State Park which commemorates the site of the cabin where Henry David Thoreau lived during the mid-1840's. A portion of Harold Parker State Forest which features swimming, picnicking and camping is located in Middleton and North Reading. Willowdale State Forest and the Bradley Palmer State Park with its beautiful gardens are located in Ipswich and are included in the MAPC Region.

The Metropolitan District Commission provides several major recreational areas for the residents of metropolitan Boston. One of the largest areas is Blue Hills Reservation, which has more than 5,400 acres.



METROPOLITAN AREA PLANNING COUNCIL (M.A.P.C.)

POPULATION, LAND AND WATER ACRES, RECREATION ACRES - 1970

BY DENSITY GROUPS

Metropolitan Area Planning Council Region

Density Group	1970 Population		Land and Water Acres		Recreation Acres		Recreation Acres per 1000 Population
	Total Population	Percent of RPA	Total	Percent of RPA	Total	Percent of RPA	
Extremely Dense	1,033,307	34.5	61,540	7	5,666	5	5.5
Very Dense	810,637	27.0	112,060	12	23,551	21	29.0
Dense	861,853	29.0	336,240	37	35,673	31	41.4
Less Dense	281,409	9.0	362,310	40	46,386	41	164.8
Open	9,335	.5	40,370	4	2,888	2	309.5
TOTAL	2,996,541		912,520		114,164		

The reservation includes two 18-hole golf courses, a ski slope with lighting for night skiing, a natural ice skating rink, bridle paths and picnic areas. The MDC also owns many miles of shoreline on the Charles River embankment and has developed boat launching sites, tennis courts, swimming pools, and paths for walking and bicycling. The Charles River Reservation also provides tot lots, playgrounds and fields for baseball as well as a music shell for summer concerts. The MDC owns ten beaches in the metropolitan area; the two largest accessible by public transportation are in Revere (135 acres) and Nantasket (94 acres). Other properties include Bunker Hill Monument and the Franklin Park Zoo, the Middlesex Fells, 17 swimming pools and 21 skating rinks.

The U.S. Department of the Interior owns several major recreation sites in the MAPC Region. The largest single site, Great Meadows National Wildlife Refuge located along the Concord and Sudbury rivers, is managed by the Bureau of Sport Fisheries and Wildlife. The Refuge contains about 2500 acres and provides a habitat for all forms of wildlife indigenous to the area. Opportunities are also available for conservation education and nature study tours for neighboring schools and institutions. A second major federal site with both recreational and historic significance is Minuteman National Historic Park, centered around the site of the great Revolutionary battle on April 19, 1776.

One of the major sites owned by the Trustees of Reservations is the Richard T. Crane, Jr. Memorial Reservation, one of the most beautiful areas in New England. Located in Ipswich, the 1325-acre reservation is the site of an English villa which is now used for dances, concerts and meetings. The exquisite gardens and paths of the villa lead to a four-mile stretch of sandy and salt-marsh beach. The Trustees of Reservations also owns World's End, a 250-acre peninsula in Hingham. Along the Ipswich River in Hamilton, Topsfield and Wenham is a 2,300-acre wildlife sanctuary, the largest site in the MAPC Region owned by the Massachusetts Audubon Society. Another large site owned by the Audubon Society is Drumlin Farm, a 220-acre site in Lincoln.

Potential Resources

More than 38,000 acres of potential recreation sites were identified in the 1970 Ourdoor Recreation and Open Space Inventory. Of these resources 47% are municipally owned and include sites such as municipal water lands, landfills and lands owned by municipal departments of Public Works. The majority of these sites are located in the very dense and dense population areas of the MAPC Region. A significant portion (22%) of the potential open-space resources are privately owned. The state owns 16% of the potential acreage. The major owners are the Department of Mental Health, which owns Boston State Hospital (198 acres), the Walter Fernald State School in Waltham (196 acres), and Danvers State Hospital (112 acres); the Department of Public Health, which owns Tewksbury Hospital (more than 900 acres); and the educational facilities of the Massachusetts State College system. The remaining 15% of the potential recreation resources is federally owned. These federal sites, which are owned by the Department of Defense, include the Natick Laboratory Annex located in the towns of Hudson, Maynard, Stow and Sudbury, Hanscom Air Force Field in Bedford and the Navy Depot Annex in Hingham.

Demand Needs

Eighty-two percent of the total population of the Eastern Massachusetts Study Area population lives in the MAPC Region and therefore it has been assumed that this Region constitutes 82% of the demand for each of the four activities. Of the total demand for the four activities combined, 40% is for swimming, 18% for picnicking, 20% for camping and 22% for boating (see table 2.8).

TABLE 2.8

DISTRIBUTION OF DEMAND AND NEED FOR FOUR ACTIVITIES

Metropolitan Area Planning Council Region

Activity	Total Annual Activity Days			
	Total Demand		Total Need	
	Days	Percent of Total Demand	Days	Percent of Total Need
Swimming	65,911,455	40	49,434,363	34
Picnicking	31,604,812	18	25,290,482	18
Camping	34,788,558	20	34,363,370	24
Boating	37,095,224	22	35,043,019	24

But on the other hand, the location of recreation lands in the MAPC Region is inversely related to population density.

This situation is particularly critical in the extremely dense population area which contains about 35% of the population and only 5% of the recreation acres. On the basis of acres per 1000 population this is only 5.5 acres, which is about one-half of generally accepted standards for city-owned recreation areas. Also, the utility, use, function and quality of the individual areas were not considered. Thus, the actual situation may not be as good as the figures portray. The same applies to the other density groups, which appear to be much better off than the more densely settled area. In addition, certain towns within each density category may deviate significantly in terms of recreational lands from the regional average for their density group. In general, facilities are not located where the people are. Swimming is primarily a day-use activity with mainly

local participation. Therefore the maldistribution of facilities is extremely critical for swimming.

Special Opportunities

Boston is unusually fortunate in the shape, variety and quantity of its natural resources. Its location on the ocean, the shape of the basin and the attractiveness of the three rivers flowing into Boston Harbor all contribute to create a naturally attractive area.

These assets have often been abused or ignored over the years. In the past much of the land-use development in the Boston area has occurred without consideration of rivers, wetlands, estuaries, shores, harbors and islands. During this period, Boston had not taken advantage of its potential. Today, however, awareness of this neglect and misuse is increasing and steps are being taken wherever possible to correct this history of abuse. The Charles, Mystic and Neponset rivers, for example, are the subject of increasing governmental environmental action and concerned citizen efforts.

The Charles River

The Charles River flows through the City of Boston and many other cities and towns in the MAPC Region. A traditional base for recreation, the Charles also has a sentimental attraction for many metropolitan area residents.

TABLE 2.9

PERCENT OF SUPPLY AND DEMAND BY DENSITY GROUPS
FOR FOUR ACTIVITIES - 1970

Metropolitan Area Planning Council Region

Density Group	Percent of Demand	Percent of Supply			
		Swimming	Picnicking	Camping	Boating
Extremely Dense	34.5	17.0	4.0	-	5.0
Very Dense	27.0	17.0	21.0	4.0	31.0
Dense	29.0	31.0	36.0	37.0	20.0
Less Dense	9.0	32.0	39.0	34.0	37.0
Open	.5	3.0	-	25.0	7.0

Source: Massachusetts Outdoor Recreation Plan
Eastern Massachusetts Supplement
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Of the three rivers which empty into Boston Harbor, the Charles has probably received the most attention. A great deal of work has been done in numerous studies to analyze the resources and character of the Charles, including pollution problems, recreational potential and proposals for protection and improvement. Among the principal public agencies involved are the Metropolitan Area Planning Council, the Metropolitan District Commission, the Department of Natural Resources, the U.S. Army Corps of Engineers, municipalities and the local conservation commissions. Studies by these agencies have provided sufficient information on the river and recommendations for its improvement so that further study of the area appears unnecessary. The time has come for action in the form of specific proposals, programs and the expenditure of funds to see these goals realized.

In the spring of 1972, at the request of the Secretary of Environmental Affairs, the MDC and the DNR established study teams to propose new projects to improve the Charles. A survey of present state projects indicates that even at the current level of effort much is already being accomplished.

The recreational opportunities of the river can be greatly expanded as well. At present there is boating in the lower basin, although the water quality is considerably below its proposed "C" classification. The Division of Fisheries and Game stocks the river's main stem and tributaries with 12,100 brown and brook trout. The Division of Marine Fisheries is attempting to reestablish a shad run. The MDC is planning bicycle paths along the lower basin and other improvements. These programs could be expanded and other opportunities developed.

A major recreational proposal recommended by the Department of Natural Resources is the development of a new regional state park in Medfield. These and other programs require funds; the General Court recently approved a bond issue for $7 million to be spent on the Charles River. Construction of sewage treatment plants account for approximately $3 million. Although this is the largest single type of expenditure, significant additional expenditures are being made or planned in land-use control, flood control, low-flow augmentation and recreation.

The Boston Harbor Islands

The Boston Harbor Islands, perhaps the most unique if not the finest natural recreational resource in New England, have tremendous potential outdoor recreational value for Eastern Massachusetts. Plans are currently being considered at all levels of government to restore the Harbor and its Islands so that they may be developed into an extensive park system emphasizing conservation of natural resources, preservation of wildlife and marine life, and provision of intensively developed recreational resources.

Chapter 742 of the 1970 Acts mandated the Department of Natural Resources to implement the acquisition, improvement, maintenance and development of the Boston Harbor Islands for conservation and recreation purposes. The final draft of the Comprehensive Plan for the Boston Harbor Islands was completed by the Metropolitan Area Planning Council for the DNR in the spring of 1972. Although the major responsibility belongs to DNR, the plan points out the need for agency coordination in efforts to improve and develop the Harbor Islands. The MDC currently owns five islands in Boston Harbor; the Commission has plans for historic preservation of these and other islands. Recommendations in the Boston Harbor Report include a program for the Environmental Protection Agency and the New England River Basins Commission to clean the waters of the Harbor and, except for the inner harbor, return them to swimming use. In addition, the Harbor Islands will provide resources for the development of important fishing, boating (including public landings and a ferry system), picnicking, camping, trails and interpretive facilities.

Table 2.10 on the following pages provides a listing of major outdoor recreation and open-space sites currently available in the MAPC area.

TABLE 2.10

SELECTED MAJOR OUTDOOR RECREATION AND OPEN-SPACE SITES

Metropolitan Area Planning Council

	Acreage
I. Department of Natural Resources, Division of Forests and Parks	
A. State Parks	
Ashland	470.0
Bradley Palmer	721.0
Cochituate	1,126.0
Cushing Memorial	7.0
Hopkington (Ashland only)	250.0
Myles Standish	29.0
Plum Island	76.0
Walden Pond	117.0
Wompatuck	2,748.0
	5,544.0
B. State Forests	
Boxford (Middleton only)	235.0
Bristol-Blake Reservation	141.0
Carlisle	58.0
Foxborough	640.0
Franklin	881.0
Harold Parker (North Reading and Middleton)	3,250.0
Marlborough	60.0
Medfield	37.0
Sudbury	233.0
Willowdale	2,075.0
Wrentham (Wrentham only)	945.0
	5,639.0
II. Department of Natural Resources, Division of Fisheries and Game	
A. Wildlife Management Areas	
Pantry Brook	393.0
B. Other	
Rocky Gutter	1,541.0

III. Metropolitan District Commission

A. Reservations

Beaver Brook	15.7
Breakheart Reservation	569.0
Blue Hills	5,489.0
Charles River	1,537.0
Middlesex Fells	2,060.0
Neponset River	937.0
Stony Brook	468.0
	11,075.7

B. Parkways

Alewife Brook	124.0
Fresh Pond	11.0
Furnace Brook	52.0
Hammond Pond	98.0
Lynn Fells	63.0
McGrath Highway	206.0
Middlesex Fells	182.0
Mystic Valley	141.0
Neponset River	57.0
O'Brien Highway	392.0
Revere Beach	133.0
Veterans of Foreign Wars	27.0
	1,486.0

C. Beaches

Havey	15.0
Lynn Shore-Nahant	97.0
Malibu	13.0
Nantasket	94.0
Orient Heights	47.0
Revere	135.0
Savin Hill	4.0
Tenean	8.0
Winthrop	55.0
Wollaston	19.0
	487.0

D. Other Properties

Bunker Hill	4.0
Castle Park, Marine Park, Pleasure Bay	89.0
Saxton Foss Park	18.0
George's Island	28.0
Hemenway Pond	270.0

Hemlock Gorge	23.0
Lovell's Island	28.0
Leo J. Martin Golf Course	66.0
Ponkapoag Golf Course	155.0
Spot Pond Area	614.0
Pools	3.0
Rinks	30.0
Franklin Park Zoo	89.0
	1,417.0

E. <u>Aqueducts and Reservoirs</u>

Cochituate Aqueduct	75.0
Hultman Aqueduct	508.0
Sudbury Aqueduct	200.0
Weston Aqueduct	443.0
Chestnut Hill Reservoir	118.0
Sudbury Watershed	3,864.0
	5,208.0

IV. U.S. Department of Defense

Coast Guard Station	2.0
Corps of Engineers	94.0
Fourth Cliff Recreation	56.0
Hanscom Field	860.0
Military Reservation	876.0
Natick Laboratory	3,678.0
Navy Depot Annex	760.0
Nike Station	14.0
	6,342.0

V. U.S. Department of the Interior

A. <u>Bureau of Sport Fisheries and Wildlife</u>

Parker River National Wildlife Reservation (Ipswich only)	2,040.0
Great Meadows National Wildlife Reservation	2,446.0
West Hill Wildlife Management Area	34.0
	4,520.0

B. <u>National Park Service</u>

Adams National Historic Site	4.7
John F. Kennedy National Historic Site	.1
Minuteman National Historic Park	508.0
	512.8

C. Miscellaneous

Cemetery and Old Ship Church	15.0
Saugus Iron Works	9.0
Sagamore Hill	30.0
	54.0

VI. Trustees of Reservations

Agassiz Rock	106.0
Appleton Farm	92.0
Charles River Peninsula	29.0
Fort Factory Brook	62.0
Governor Hutchinson's Field	10.0
Halibut Point	12.0
Meadow Lots	16.0
Medfield Rhododendrons	109.0
Misery Island	82.5
Mount Ann Park	87.0
Noon Hill	52.0
Norris	99.0
Old Manse	8.0
Crowninshield Island	5.0
Pegan Hill	31.0
Pierce Hill	6.0
Pine and Hemlock	14.0
Richard T. Crane, Jr.	1,326.0
Rocky Narrows	53.0
Henry L. Shattuck	200.0
Whitney and Thayer Woods	795.0
World's End	249.0
	3,443.5

VII. Massachusetts Audubon Society

Broadmoor	175.0
Drumlin Farm Wildlife Sanctuary	220.0
Eastern Point Wildlife Sanctuary	26.0
Highland Farm Wildlife Sanctuary	44.5
Ipswich River Wildlife Sanctuary	2,300.0
Little Pond Wildlife Sanctuary	262.0
Marblehead Neck Wildlife Sanctuary	15.0

Moose Hill Wildlife Sanctuary	227.0
Nahant Thicket Wildlife Sanctuary	4.0
Hemlock Pond	15.0
Waseeka (Holliston only)	93.0
Rocky Knoll Wildlife Sanctuary	2.0
Stony Brook Wildlife Sanctuary	2.0
Straitsmouth Island	33.0
Wild Pond	12.0
	3,430.5

Source: Massachusetts Outdoor Recreation Plan
Eastern Massachusetts Supplement
pp VIII-14 through VIII-18

3.0 LAND USE

3.1 Major Findings and Conclusions

Impacts of Treatment Facilities

1. Because so many of the treatment plants proposed are common to all five engineering concepts, differential impacts on local land use are not substantial. Expectably, concepts 4 and 5, being the most decentralized, involve the greatest number of conflicts, while concept 3 causes the least conflict since it calls for the smallest number of plants to be constructed or expanded.

2. This very preliminary inspection of potential land use conflicts should be interpreted only as a first step suggesting where further investigation of suitable sites or site mitigation measures should be undertaken, rather than be used as a basis for evaluating the different concepts; it may well be that alternate sites could be found that avoid the conflicts identified, or that adequate site screening, for example, could be provided where adjacent land uses appear to be infringed upon.

Impacts of Land Application Sites

1. In general, the towns involved in concept 5 have a relatively abundant supply of vacant land capable of being developed with on-site sewage disposal systems, and these communities are not experiencing pressures for rapid development; consequently, future growth, including recreation needs, should not be constrained by allocation of the proposed acreages to effluent disposal.

2. The majority of selected disposal sites are quite remote from existing and planned development centers. Land affected that is now privately owned would be expected in most cases either to remain as open space or to develop only very gradually.

3. Potentially adverse impacts of major importance that will requite further technical assessment before conclusions can be reached are: (a) possible contamination of existing aquifers as the result of a large-scale application of incompletely treated effluent, and (b) possible damage to numerous cranberry bogs from nutrients contained in the effluent and potential drainage problems associated with the application of large volumes of effluent on nearby land.

<u>Impacts of New Interceptors</u>

1. With the exception of the Upper Charles and the Hopkinton-Marlborough-Southborough sub-areas, the proposed interceptors do not differ across concepts and thus do not lend to differential impacts.

2. In the Upper Charles River sub-area, the impact of the proposed interceptors is not expected to be great in terms of major land use changes. A large proportion of the areas proposed for sewering are already-developed older residential areas, and the demand for new industrial and commercial sites in the sub-area is not great. Gradual growth of population and residential acreage in the sub-area would be expected in any case since much of the sub-area is suitable for on-site sewage disposal. The principal exception seems to be Medfield, which generally has soils unsuitable for on-site disposal and which is projected to have the largest growth of any Town in the sub-region, 1970-1990, assuming development of future sewerage systems.

3. The Towns in the Upper Charles sub-area have extensive swamps and wetlands from which the headwaters of the River arise. Some of the areas proposed for future sewerage appear to encroach on these wetlands.

4. In addition, gradual development of the Upper Charles River Basin, regardless of sewer interceptors, will significantly reduce forested acreage in this sub-area, with potential effects upon run-off into the Charles.

5. Location of the interceptors along the Charles River (to different degrees under different Concept plans) will tend to encourage higher intensity uses to concentrate in this corridor.

6. The Hopkinton-Marlborough-Southborough sub-area is in a more rapidly growing part of the state than is the Upper Charles sub-area. Expanding sewer capacity here therefore has a much greater potential for "triggering" further development. Ashland and Framingham are expected to grow rapidly in the 1970-90 period. However, these communities are already tied into the existing MDC system, so the impact of the proposed new interceptors will be limited to concentrating this potential growth in the interceptor corridors. The greatest potential change attributable directly to the proposed new interceptors could come in Hopkinton, which had no existing system in 1970.

7. A number of "external" impacts have also been identified, including continued enhancement of downstream riverbanks for future development as the "clean-up" of the river continues; the probable continued trend toward lower densities in the core area as the concomitant of further suburban growth; and the possibilities of "opportunities foregone" as the result of the adoption of any of the proposed Concept plans.

3.2 Land Use Impacts of Treatment Facilities

The first general impact of the proposed engineering concepts on land use concerns the construction or expansion of sewage treatment plants. By their nature these impacts are site-specific and, as such, fall more closely under the scope of work of the aesthetic and cultural contractor. This section will simply enumerate the types of potential land use conflicts posed by the five engineering concepts, highlighting where they differ across individual concepts. The material necessarily draws very heavily on the site investigations conducted by Whitman and Howard, Inc.

Table 3.1 below summarizes this information by type of conflict

TABLE 3.1

TYPES OF CONFLICT	SITE OF TREATMENT FACILITY	SEVERITY OR CONFLICT MAJOR	MINOR	CONCEPTS INVOLVED IN CONFLICT 1	2	3	4	5
Conflict with Existing Use of Site	Medford (Recreation Space)	X					X	X
Conflict with Existing Adjacent Uses	Essex	X		X	X	X	X	X
	Rockport		X	X	X	X	X	X
	Hamilton	X		X	X	X	X	X
	Marshfield	X		X	X	X	X	X
	Medway (Rec. & Resid.)	X		X	X		X	X
	Gloucester-Magnolia		X	X	X	X	X	X
Use of Floodplain/Wetland	Sudbury	X		X	X	X	X	X
	South Canton	X			X			
	Canton	X					X	X
Conflict with Planned Residential and Commercial Development	Scituate	X		X	X	X	X	X
	Cohasset	X		X	X	X	X	X
	Dedham		X		X		X	X
	Essex	X		X	X	X	X	X
Conflict with Planned Industrial Development	Woburn		X				X	X
	Lynn (Possible site of Powerplant)		X	X	X	X	X	X
Conflict with planned recreation/open space uses	Scituate	X		X	X	X	X	X
	North Canton	X			X			
	Gloucester--Route 133	X		X	X	X	X	X
	Hudson		X	X	X	X	X	X
	Medfield		X	X	X		X	X

and by individual concept. The decentralized options (concepts 2,4) create the largest number of land use conflicts, as expected since they involve the largest number of proposed facilities. However, it should be noted that 13 instances of conflict occur under all five of the concepts, indicating problems with the peripheral systems.

3.3 Land Use Impacts of Land Application Sites

3.3.1 Introduction to the Analysis

A preliminary survey by Whitman and Howard, Inc. of potential sites for the land application of treated wastewater from five regional treatment plants (Woburn, Medford, Watertown, Dedham, and Canton) included sites both inside and outside the BH-EMMA study area. However, subsequent application of more stringent public health criteria requiring extensive buffering of sites to protect dwellings, public water supplies and roads, narrowed the suitable sites to areas that were all outside the study area. The current proposal calls for conveying the effluent from the five regional plants via a system of tunnels and force mains to land application sites in eleven southern Massachusetts towns: Plymouth, Carver, Wareham, Sandwich, Bourne, Berkeley, Lakeville, Freetown, Fall River, Westport, and Dartmouth. The acreage involved in the various towns ranges from only 10 acres in the Town of Westport, to 6085 acres in the Town of Plymouth.

The land use issues that are raised by concept 5 are those concerning possible conflicts with existing and future uses of the proposed disposal sites and adjacent land areas; the impact on the overall availability of land for future town needs; and the transfer of now privately owned, taxable land to the public domain. In all cases, the town land that would be used for effluent disposal is prime developable land (except where the land is publicly owned) since spray irrigation and rapid infiltration sites necessarily use land that is well drained and not very hilly. Consequently, the major land use issue that was addressed in the present study was the potential impact of the land disposal proposals on town development plans. A matter related to land use that has not yet been explored is the possibility of reserving some additional land, at a suitable distance from disposal sites, in which to sink wells to reclaim water for local use or conveyance back to Metropolitan Boston.

The relative absence of identifiable land use conflicts does not imply that the towns involved in concept 5 will consequently be receptive to the land application proposals. It appears, rather, that the viability of concept 5 will hinge to a far greater extent on political and hygienic considerations than on expected land use impacts. While there are potential benefits associated with land disposal systems, such as preservation of open space, possible recreational and industrial use of recovered water, and agricultural use of effluent nutrients, it is questionable how attractive these potential benefits would be to the towns in question. The communities affected already have an ample supply of open space and recreation-oriented water bodies that are not likely to succumb to undesired development pressures in the foreseeable future. Furthermore, there is limited experience combining the scale of operations proposed and a comparable geopolitical context on which to evaluate the benefits of industrial and agricultural use of land-treated effluent. What these towns would be trading off for the above mentioned benefits is the likely removal of varying amounts of land from municipal tax rolls, and the acceptance of wastewater from Metropolitan Boston sewage systems in which they play no part. This is a very different matter, politically, than an arrangement among a number of towns to jointly collect and dispose of their own wastewater in a regional system designed to serve a mutual need. Under the present proposal the element of mutual interest is not immediately evident. Moreover, since the source of the wastewater to be applied to the land is a highly urbanized, industralized area, strong assurances regarding the efficacy and reliability of treatment, both before and after arrival of the effluent, will have to be provided to convince receiving towns that public health and local agriculture will be adequately protected.

Another questions is that of restricted public access to the land application sites. Theoretically, the major portion of spray irrigation sites would be available for outdoor recreation or agriculture/silviculture. The extent of availability to the local community would depend on both the engineering design of the sites and, in the case of agriculture/silviculture, the institutional arrangements made for such use. Land used for rapid infiltration systems would be available and desirable for recreation only if attractive path systems were provided on the sites.

Analysis

The proposed land application site locations were provided by Whitman & Howard, Inc., mapped out on U.S.G.S. quadrangle sheets. These plans were compared with town zoning plans and maps of existing and future land use contained in master plans. (In the case of Berkley, Fall River, Carver, Freetown and Dartmouth, for which master plans were not available, information was obtained through conversations with staff members of the Southeastern Regional Planning and Economic Development District (SERPEDD) and the State Department of Community Affairs.

Presented below is a town-by-town assessment of the land use impacts of concept 5, describing acreages involved and the relationship of proposed sites to existing and future town land use.

Town of Plymouth

- Total acreage proposed for spray irrigation: 6085
- Total acreage proposed for rapid infiltration: 0

- Acres now publicly owned: 3336
- Acres apparently privately owned: 2749

The Town of Plymouth has an area of 103.57 square miles (65,632 acres), the largest area of any town in Massachusetts. According to the town master plan[1], topographic and soil characteristics are such that practically all of the town land is capable of being developed. Even though Plymouth has numerous lakes and ponds and a long shoreline, a very small proportion of land is wetlands and swamps. The 1966 inventory of Plymouth's land use was as follows:

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[1] Plymouth Compact III: A Comprehensive Plan for Plymouth, Massachusetts, Adams, Howard and Oppermann, City Planning Consultants, Cambridge, Mass., 1966.

Land Use Category	% of Total	Acres
Residential	5.27	3,465
Commercial	.21	140
Industrial	1.43	940
Agricultural	4.13	2,714[1]
Public & Quasi-Public Buildings	.25	165
Public & Quasi-Public Open Space & Recreation	15.24	10,005
Vacant	63.61	41,357
Highways	2.25	1,474
Water & Swamps	8.18	5,371
TOTAL	100.00	65,632

The only urbanized portion of Plymouth is the area between Route 3 and the coast in the northeast section of the Town. Older development has taken place along the highways, and recent development generally in subdivisions leading off existing roads. According to the master plan, residential development is expected to occur within or near the existing neighborhoods of North Plymouth, Plymouth Center, Chiltonville and Manomet; the amount of developable land in these areas is considered more than adequate to meet the maximum projected 1985 needs. Future industrial development is planned exclusively along Route 3 and a small area adjacent to the Municipal Airport. The amount of land available for industry in these areas is far greater than expected demand.

[1]Approximately 1500 of these acres are cranberry bogs.

Approximately 3300 acres of the total 6085 acres proposed for land application sites in Plymouth lie within the Myles Standish State Forest, which occupies some 9600 acres of the Town. The sites within the State Forest are designed to include a 1000' buffer around all ponds, permanent campsites and lodgings, and a 200' buffer along roads. Recreational use of the State Forest could continue on most of the area of the sites, all of which are proposed as spray irrigation systems. It is assumed that provision will be made for posting spraying schedules to alert recreation users in the area.

All of the proposed effluent disposal sites in Plymouth, both publicly and privately owned, lie to the west of Route 3. All sites located outside the State Forest are shown on the Future Land Use Plan as "Vacant and Agriculture", and are designated "Rural" on the 1966 Proposed Zoning Map.

<u>Town of Carver</u>

- Total acreage proposed for spray irrigation: 1012
- Total acreage proposed for rapid infiltration: 0
- Acres now publicly owned: 947 (Myles Standish State Forest)
- Acres apparently privately owned: 65

A land use plan for Carver was not available. According to SERPEDD, Carver has a large supply of developable land and is not experiencing development pressures. The one large spray irrigation site proposed here is located in the easternportion of the Town, North of Cranberry Road, well away from developed areas. Thre are only scattered buildings along existing roads in this area. Any intensive development in the future is expected to occur along the ponds west of the proposed site. There are, however, numerous large cranberry bogs in the vicinity of the disposal site; the potential impact on these operations of nutrients in the deposited effluent should be carefully studied before land application is undertaken here.

Town of Wareham

- Total acreage proposed for spray irrigation: 813
- Total acreage proposed for rapid infiltration: 0
- Land in all sites appears to be privately owned.

The total land area of the town is 21,759 acres. According to an inventory conducted in 1963[1], 4988 acres were developed and 16,771 acres were vacant. (This "vacant" category excludes natural ponds, flowed impoundments and wetlands.) Of the vacant land, some 1100 acres were estimated to be developable if provided with flood control devices, and 15,000 acres were judged to have no problems for development other than the remoteness of some areas. Land use projections for 1980 showed 6100 acres of developed land and 15,659 vacant acres. In making these projections of future land use needs in Wareham, the authors of the master plan note that "Perhaps the most significant point in this is that even twenty years from now and many decades later, there will be an enormous amount of vacant land available."

The three sites proposed for effluent disposal are all located in the northeast corner of the town, north of Route 25. All of the sites are shown on the Future Land Use map of 1964 as "largely undeveloped". Here again, however, the area abounds with cranberry bogs and also town wells both of which could potentially be subject to severe impact from nutrients in the deposited effluent.

Town of Sandwich

- Total acreage proposed for spray irrigation: 0
- Total acreage proposed for rapid infiltration 2247
- Land involved is entirely publicly owned (Otis Air Force Base)

A single large rapid infiltration site is propsed for the central portion of Otis Air Force Base land, containing 2747 acres of mainly quite flat terrain. 2247 acres are in the Town of Sandwich and 498 acres in the

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[1] Comprehensive Plan for Wareham, Massachusetts, Wareham Planning Board, Economic Development Associates, Inc., Boston, Massachusetts, 1964.

Town of Bourne. This land is, of course, already publicly owned, and is remote from any developed areas. Although the future of the Base land is unknown at present--a variety of uses are being proposed--a rapid infiltration facility here would be compatible with adjacent open space and recreation or agricultural uses. The site itself offers possibilities for certain kinds of agricultural use, such as cultivation of rice or other crops suitable for a high-moisture environment, provided contamination from the effluent is determined not to be a problem.

Town of Bourne

• Total acreage proposed for spray irrigation:	364
• Total acreage proposed for rapid infiltration	863
	1227 acres
• Acres now publicly owned:	498 (Otis Air Force Base)
• Acres now privately owned:	729

Of the total 1227 acres in Bourne proposed for effluent disposal, 498 acres lie within Otis Air Force Base. The remaining 729 acres are distributed among four sites, two proposed for rapid infiltration and two for spray irrigation, all of which are located north of the Cape Cod Canal, west of Route 3.

According to the Bourne Master Plan of 1966[1], the forested area at the northern end of Otis Air Force Base is expected to remain an open wooded area. Although there are no existing plans for the central portion where rapid infiltration is proposed, this area is relatively inaccessible and quite distant from any existing development. It is therefore reasonable to suppose that the two rapid infiltration sites proposed here, along the Bourne-Sandwich boundary, would also remain as open space.

The area north of the Canal containing the other proposed disposal sites is described in the Master Plan as "Sparsely developed and off the beaten track relative to other community development." In terms of compatibility of land use, the sites do not conflict with the recommendation for low

[1] Bourne Master Plan, Economic Development Associates, Inc., Boston, Mass., 1966.

density development and conservation areas in this area of the town. However, the land area proposed for effluent disposal constitutes approximately a third of the open land area here north of the Canal. The tax loss to the community might be significant as the area in question is considered to be potentially one of the most attractive residential areas in the town; it is free of through traffic but close to regional routes, and residential estates are the type of development envisaged by the Master Plan. The Proposed Zoning Map of 1966 designates this entire area as R-40 Residential.

The acreage proposed for land application sites does not, however, constitute a large proportion of the town's total privately owned open land. The 1966 Master Plan stated that no more than 2,000 of the 11,000 acres of privately owned open land would be needed for future growth over the next twenty years. A program of extensive acquisition of conservation land (up to 2,000 acres) was recommended. The potential land use problem posed by the proposed disposal sites, then, is that they are concentrated in a relatively highly valued area of the town, where they might limit development to an undesirable degree, although overall community growth would not be constrained.

The potential impact of disposal sites on cranberry bogs in this area must also be taken into account.

Town of Berkley

- Total acreage proposed for spray irrigation: 1182
- Total acreage proposed for rapid infiltration: 0
- All five sites are apparently privately owned.

No master plan was available for the Town of Berkley. According to the planning staff of SERPEDD, however, there is no significant development in the vicinity of the proposed disposal sites, which are away from roads except Bryant Street in the Bryant Hill area and Anthony Street. These streets cross spray irrigation sites, but there appear to be no buildings along the portions of the roads within the sites.

Berkley has a small population and no real population center; development is scattered along existing roads. There is no public water or sewer service in the town, and growth is expected to be gradual. Berkley

does not appear to have any cranberry bogs in the area of the propsed disposal sites.

Town of Lakeville

- Total acreage proposed for spray irrigation: 575
- Total acreage proposed for rapid infiltration: 152

727 acres

- All land affected is apparently privately owned.

The proposed disposal sites in Lakeville are located in the southwest corner of the town and on either side of the New York, New Haven and Hartford Railroad line along the Lakeville-Freetown boundary. Lakeville's Future Land Use Map of 1969-1970[1] shows the affected area west of the railroad as "Residential-Rural Low Density and Agriculture". East of the railroad, the area south of the Apponequet Regional High School is shown as "Residential-Suburban Low Density". A 63-acre rapid infiltration site proposed here would limit development in this particular area of Lakeville.

Since there is no public water or sewer service in Lakeville, any development pressures are expected to be concentrated in the most suitable soil areas, which are located in the northern portion of the town, and to the south of Assawompset Pond. The remaining suitable areas are those in the vicinity of the proposed disposal sites, in the southwest portion of Lakeville. A lesser extent of development pressure is anticipated in this area, according to the master plan. The northeast section contains the most dense development, and it is here that new development is greatest. Overall, the town has both large areas of wetlands, which are recommended for preservation as wildlife refuges, and also thousands of acres of vacant land which could be developed. If growth pressures should increase in Lakeville, the town is capable of absorbing "vast amounts" of development, even with the large lot size requirements of on-site sewage systems.

Although there appear to be no cranberry bogs in the vicinity of the proposed disposal sites in Lakeville, there is a very large cranberry bog

[1] Master Plan for Lakeville, Massachusetts, 1969-1970, Metcalf and Eddy, Inc.

in Freetown, close to a spray irrigation site that is shared by the two towns.

Town of Freetown

• Total acreage proposed for spray irrigation:	1395
• Total acreage proposed for rapid infiltration:	55
	1450 total acres
• Acres now publicly owned:	93 (Freetown-Fall River State Forest)
• Acres apparently privately owned:	1357

A master plan for Freetown was not available. Planning staff of SERPEDD with whom we reviewed the proposed disposal sites did not identify any conflicts with existing or proposed land use in the town. Freetown has a large supply of developable open space and is growing at the rate of only 2-3% annually. New development is occurring mainly to the west of the Freetown-Fall River State Forest, along the Assonet River. The disposal site that is located closest to existing development lies within the State Forest. This is a spray irrigation site of 93 acres, in the Breakneck Hill area, and would be compatible with recreational use of the forest area. A 178-acre spray irrigation site is proposed north of the State Forest between Richmond and Howland Roads, where gradual residential development is occurring. The remaining sites are in areas that are likely to remain open, or to develop only slowly.

The principal element of concern from the point of view of potential land use impacts is the close proximity of two of the spray irrigation sites to a large cranberry bog north of the State Forest. The likelihood of contamination and drainage problems from effluent disposal must be further studied here.

Town of Fall River

- Total acreage proposed for spray irrigation: 4417
- Total acreage proposed for rapid infiltration 0
- Acres now publicly owned: 1523 (Freetown-Fall River State Forest & Watuppa Reservation)
- Acres apparently privately owned: 2894

As a land use plan for Fall River was not available, our information is based on conversations with the planning staff of SERPEDD. All of the effluent disposal sites proposed in Fall River are located to the west of Route 24. The 1523 acres of spray irrigation sites within the State Forest and Watuppa Reservation would be compatible with the open space and recreational use of these preserved areas. The 2894 acres of spray irrigation sites proposed in areas that are apparently privately owned lie to either side of the Copicut Reservoir and southeast of the Watuppa Reservation. Although this area of Fall River is zoned for low density residential development, there is no existing development, and no significant amount of future development is expected since there is no good road access, and the space is probably not needed for future town growth.

A potentially very serious conflict is posed by the proposed use of the Copicut watershed for effluent disposal. The Copicut Reservoir is a public water supply, and the risk of contaminating it must be carefully assessed before a decision is made to deposit effluent here.

Town of Dartmouth

- Total acreage proposed for spray irrigation: 164
- Total acreage proposed for rapid infiltration: 0
- Land in all 3 sites appears to be privately owned

The three spray irrigation sites proposed in Dartmouth are located along the Dartmouth-Fall River boundary and are extensions of sites in Fall River. Although a land-use plan was not available, it does not appear

that the sites infringe on any existing development. The acreage proposed to be used should have no adverse impact on the availability of developable open space in Dartmouth. Of a total town area of 60.9 square miles, total buildable land is 28,403 acres, or 71.8%, and prime development land is 2916 acres. In 1957 only 7% of the town was developed, and only 448 additional acres were proposed for future residential development.[1]

The proposed 146-acre spray irrigation site east of the Copicut Reservoir is part of a larger site in Fall River that could potentially endanger water quality in the reservoir. There do not appear to be any cranberry bogs in the vicinity of the proposed disposal sites.

<u>Town of Westport</u>

- Total acreage proposed for spray irrigation: 10
- Total acreage proposed for rapid infiltration: 0
- Site appears to be privately owned.

The 10 acres proposed for spray irrigation in Westport are located in the extreme northeast corner of the town and are an extension of a 316-acre site in the Town of Fall River. The Westport zoning map of 1964[2] shows the entire northern portion of the town above Old Bedford Road zoned "Rural Residence". The proposed site is remote and not readily accessible from developed areas. There do not appear to be any cranberry bogs in the vicinity of the site.

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[1] "Land Use, Present and Future", a Memorandum to the Dartmouth Planning Board from Planning and Renewal Associates, 1957.

[2] <u>Comprehensive Report on the Westport Master Plan</u>, Economic Development Associates, Inc., Boston, Mass., 1964.

3.4 Land Use Impacts of Proposed New Interceptors

3.4.1 Introduction, Method and Problems with Method

This section of the report concentrates on two geographical sub-areas:

- The Upper Charles River interceptor extension sub-area; and
- The Ashland-Framingham interceptor extension sub-area.

These are the first two sub-areas to be analyzed since it is only in these sub-areas that there are any differences among the five alternative Concept plans. The method developed here could be subsequently extended to the other proposed interceptors that are the same for all Concepts.

The method that has been used is not highly rigorous. The planning data provided by the M&E run of the Empiric Model has been used as an indication of expected future changes in population, employment and land use in the communities involved.[1] No data is available from comparable runs that might have been based on the assumption that the areas proposed for sewering were not sewered or that interceptors were not provided. The degree of projected change that is attributable to the proposed new interceptor system cannont therefore be calculated from existing data sources. In addition, little data was available on the proposed actual timing and scheduling of improvements, or on the possibility of alternative (e.g. non-structural) solutions to sewering problems.

Given these limitations, the method that has been used was to map the areas suggested for sewering (shown in previously published reports by Camp, Dresser and McKee for the MAPC). These areas have been drawn in on USGS quadrangle maps. (See section 11, Appendix). Areas which have been suggested for sewering but which were indicated as currently undeveloped on these maps were then considered to be the areas where the greatest land use changes might potentially take place. These areas were evaluated to the extent possible based upon land and water characteristics shown on USGS maps, existing planning documents prepared by local communities and by the State Department of Community Affairs, and the MAPC Open Space Plan.

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[1] Only the 1970-1990 projection period was considered; and for simplicity the High 1990 projections were consistently used in discussing the projections. High and low projections and changes from 1970 are shown in the Appendix tables to this report.

Particular attention was given to the degree to which the total areas proposed for sewering were already built-up, the availability of local treatment plants, and the extent to which local planning documents mentioned the need for interceptors as a precondition for growth. Wherever possible, inferences were then drawn regarding the actual impact of the interceptors themselves as compared with generally expected growth or change in the sub-area.

Finally, "interceptor corridors" were analyzed briefly. The precise location of an interceptor will probably not have a major impact upon the long-term growth trends of a sub-area as a whole. However, the pattern of development intensities within the region may be affected, since higher-intensity development (apartments, business and industry) will be more economical to sewer if they are located near an interceptor.

3.4.2 Upper Charles River Sub-Area

General Description and Problems

These Towns presently consist to a large extent of open, undeveloped land, including extensive wetlands, fields and forests. The topography is hilly and there are many streams and natural and manmade ponds.

Existing Town centers are usually clustered around old mills originally built near streams and ponds to take advantage of the available water power.

There is also a wide variety of soils and subsurface conditions varying from outcroppings of bedrock to well-drained soils which appear to be able to sustain foreseeable residential development for the remainder of this Century.

Many of the critical considerations relating to the future sewering of this area arise from the situation that these Towns taken together are the principal sources of the headwaters of the Charles River. New development in these areas will probably therefore have an impact upon the quality and quantity of water flowing downstream, and upon the entire Charles River Basin.

The Metcalf & Eddy run of the Empiric Model projects, for the 1970-1990 period, an increase in "used land" of 7010 acres in the eight Towns in the Upper Charles River sub-area. Of this, 5960 acres would be an increase in "net residential" acres. Increased land devoted to streets and highways would use up another 790 acres. Assuming that this 7800 acres was originally half-forested and that the forested areas are 75% cleared when used (on the average), this would indicate a potential loss of some 2900 forested acres in the sub-area during 1970-1990. The proportion of this that can be attributed to the proposed sewer system, however, is hard to estimate since much of this loss will occur irrespective of the system. Sewering will therefore have a direct effect of reducing the run-off into the river (by removing polluted water from the river); but the indirect effect will be to encourage development that will result in higher run-off.[1]

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[1] Note: A run-off decrease would occur only in Concept 3 in the Upper Charles sub-area. The other Concepts all would discharge treated sewage back into the Charles River. In the Framingham-Ashland area, Concepts 1 and 3 tie into the MSD system, while 2 and 4 discharge treated sewage locally into the Sudbury River, the "natural" basin for most of this area.

Bellingham

% Developable Land Sewered in 1970: 0

1970-1990 Projection

Increase in "used" land: 439 acres

Increase in "sewered" land: 1830 acres

There are three suggested areas for sewering in Bellingham. The southern area bordering Rhode Island is already relatively built up except for the area south of Wrentham Street and east of Paine Street. This area adjoins Bungay Brook and includes some wetlands. All of the southern part of Town is outside the Charles River Basin and drains south into Woonsocket, R.I., as would the proposed sewer system here.

In the Town Center there is a large unused area proposed for sewering to the east of the High School and north of Silver Lake. This appears to be high ground.

In the northern part of the Town there are also large open areas suggested for sewering in the vicinity of Route 495, and future growth in the Town is expected to be concentrated in this area. An area south of Route 495 on Maple Street seems large enough for development without encroachment on the adjacent Charles River wetlands, and the Town of Franklin has also considered industrial zoning in a smaller adjoining area just across the Town line to the east. Some of the other areas included in the suggested sewer plan, however, appear to be wetlands on existing maps, e.g.:

(a) along Pine Street near the Franklin Town line (Mine Brook);

(b) north of Route 495 and west of Hartford Avenue (Stall Brook).

Franklin

% Developable Land Sewered in 1970: 9%

1970-1990 Projection

Increase in "used" land: 1285 acres

Increase in "sewered" land: 854 acres

Franklin has the second largest projected growth in most indicators among the eight Towns in the sub-area for the 1970-1990 projection period. This growth apparently is not strongly related to the proposed sewering, however, since the Town has the second smallest increase in proposed sewered acreage. The Town is on Route 495, and is closer to Route 95 than any other Town except Wrentham. There are large areas indicated in the Town's Comprehensive Plan as suitable sites for future residential development which have not been included in the suggested areas to be sewered. The proposed areas for sewering are almost entirely north of Route 495. Much of this area is already built up. Exceptions are:

- the Bright Hill area and wetlands to the east;
- the area near the gravel pits west of Pond Street;
- a triangle between Maple and Lincoln Streets which appears to be wetlands;
- the Pigeon Hill area;
- a strip between Chestnut Street and the railroad tracks.

Areas of special concern are along Mine Brook, which flows into the Charles. Mine Brook, West Central Street and Route 495 all criss-cross at various points throughout the Town and some areas along the brook have been proposed for industrial development.

Holliston

% Developable Land Sewered in 1970: 0

1970-1990 Projection

Increase in "used" land: 1213 acres

Increase in "sewered" land: 2419 acres

A large proportion of the area suggested for sewering in Holliston was already built-up and in residential use in 1970.

Sewering itself, therefore, is not projected to be the immediate cause of major increases in the net amount of land used in the Town. Much of the projected increase in "used" land for residential purposes will probably occur outside of sewered areas. (It may require sewering at a later time, however.)

There is a large flat open, low area southeast of the Town Center between Strawberry Hill and Nob Hill which might be subjected to some pressure for filling and development when sewered.

Sewering would also permit higher density development in already-developed areas. The M&E run of the Empiric Model, however, assumes that density will remain constant over the 1970-1990 time period at 2 households per acre.

Medway

% Developable Land Sewered in 1970: 2

1970-1990 Projection

Increase in "used" land: 598 acres

Increase in "sewered" land: 2104 acres

Medway lies in the range just below the median in terms of projected population, "used" land and "sewered" land for the period 1970-1990. The proposed areas for sewering are generally areas where some development already exists, and density is projected to increase from 2 to 3 households per acre over the time period.

There are large open areas proposed for inclusion in sewered areas in the following locations:

(a) a large triangular area to the east of the Town Center bounded by Village Street, the old railroad grade, and the Millis Town line;

(b) a large area to the west of the high school between Main Street and the old railroad grade;

(c) an area east and west of Summer Street just south of Milford Street;

(d) two areas south of Village Street along the banks of the Charles River.

Of the above, (a) seems to have the greatest potential problem for development, since it is largely shown as swampy area on existing maps.

Medfield

% Developable Land Sewered in 1970: 3%

1970-1990 Projection

Increase in "used" land: 1515 acres

Increase in "sewered" land: 3540 acres

Medfield has the greatest projected increase in both "used" land and "sewered" land, 1970-1990, of any Town in the sub-area. It also has the greatest projected increase in population: 6665 persons; the greatest projected increase in "net residential" land: 1294 acres; the greatest projected increase in employment: 3806 persons; and the greatest projected increase in industrial land: 119 acres.

Medfield's soils are relatively unsuitable for on-site sewage disposal, with hard-pan from 2 to 10 feet below the surface and rock outcroppings prevalent in the large undeveloped northeast and southwest corners of the Town. The existing sewerage serves only a small area near the Town Center, which, coincidentally, is where the best-drained soils are located.

Much of the land suggested for sewering in Medfield appears to have relatively steep slopes, raising some question as to its suitability for development compared to flatter land in nearby locations. The projections of Medfield's future growth may turn out to be somewhat high for this reason. Residential density is expected to remain at 2 households per acre during the 1970-1990 period, so the projections apparently do not anticipate clustering.

Two large areas indicated in a previous comprehensive plan for Medfield as being very suitable for development lie along the Penn Central railroad tracks just north and northeast of Medfield Junction. The Mill Brook flows through one of these areas into the Charles River.

Milford

% Developable Land Sewered in 1970: 32%

1970-1990 Projection

Increase in "used" land:	294 acres
Increase in "sewered" land:	112 acres

Milford currently has the largest number of sewered acres and the largest per cent of developable land sewered of any Town in the sub-area. It also has the smallest projected increase, 1970-1990, in both "used" and "sewered" acres.

There are large areas included in suggested areas to be sewered along Route 495 in Milford. There are two major interchanges along Route 495 in the Town. However, apparently because of its distance from the Route 95 and Mass. Turnpike growth corridors, Milford is not projected to be a growth area in the model, and total employment is projected to increase by only 69 persons during the 1970-1990 period.

The proposed sewering plans are therefore expected to have little impact upon land use in Milford.

Millis

% Developable Land Sewered in 1970: 6%

1970-1990 Projection

Increase in "used" land: 826 acres

Increase in "sewered" land: 3016 acres

Millis is the second smallest Town in this sub-area in terms of total acres, and the smallest in terms of total population. Much of Millis is comprised of wetlands along the Charles River, Bogastow Brook, and Great Black Swamp. The Town, however, has the second largest proposed increase in sewered acreage.

Much of the proposed area for sewering in Millis consists of already developed land. However, there are some currently relatively undeveloped areas proposed for sewering in the western part of the Town. Near Bogastow Pond and along Bogastow Brook, future development would require filling; and this can be considered a sensitive area.

The area between Main Street and the railroad tracks in the northeast corner of the Town, which is also proposed for sewering, could be considered a sensitive area because of the possibility of run-off directly into the Charles River marshes.

Population density is projected to increase from 2 households per acre in 1970 to 3 in 1990.

Interceptor Corridor

Proposed new interceptors, in addition to stimulating general growth and development in the sub-area, will tend to attract higher intensity uses to areas near the interceptor. Since in Concept 3 a major interceptor would parallel the Charles River for most of its length, this concept would create the greatest pressures for development in areas near the River. A community such as Dover, with strong development regulations, could probably resist such pressures; while a community such as Norfolk (currently not planned for sewering until after 2000) might be significantly affected.

TABLE 3.2

SUMMARY: PROJECTED LAND USE CHANGES
UPPER CHARLES RIVER SUB-AREA, 1970 - 1990, EMPIRIC MODEL (IN ACRES)

	TOTAL "USED"	NET RES.	NET COMM.	NET IND.	TOTAL "COMMITTED"	STS. & HWYS	OPEN SPACE	TOTAL SEWERED	RATIO OF CHANGE IN TOTAL "USED" CHANGE IN TC "SEWEREL
BELLINGHAM	+ 439	+ 322	+ 67	+ 50	+ 79	+ 57	+ 22	+ 1830	0.24
FRANKLIN	+ 1285	+ 1130	+ 87	+ 66	+ 180	+ 110	+ 70	+ 854	1.50
HOLLISTON	+ 1213	+ 1067	+ 89	+ 56	+ 208	+ 140	+ 68	+ 2419	0.50
MEDFIELD	+ 1515	+ 1294	+ 102	+ 119	+ 269	+ 179	+ 90	+ 3540	0.43
MEDWAY	+ 598	+ 422	+ 115	+ 61	+ 110	+ 79	+ 31	+ 2104	0.28
MILFORD	+ 294	+ 303	- 28	+ 19	+ 43	+ 32	+ 11	+ 112	2.62
MILLIS	+ 826	+ 714	+ 88	+ 24	+ 148	+ 96	+ 52	+ 3016	0.27
WRENTHAM	+ 840	+ 708	+ 72	+ 60	+ 100	+ 100	0	+ 2763	0.30
TOTAL FOR THIS SUB-AREA	+ 7010	+ 5960	+ 592	+ 455	+ 1137	+ 793	+ 344	+ 16638	0.42

3.4.3 Hopkinton-Marlborough-Southborough Sub-Area

General Description and Problems

The communities that would be affected by the proposed extension of the existing interceptor which presently terminates at the Ashland-Framingham line are Ashland, Framingham, Marlborough, Southborough and Hopkinton. Only those parts of these communities lying within the Sudbury River watershed would be affected by the extension of this interceptor.[1]

Ashland and Framingham are already connected to the MSD system. For those communities, therefore, the only impact that need be considered in this report is that which may occur in the immediate vicinity of new interceptors, i.e., possible intensification of development there.

Parts of Westborough and Northborough also are included in the Sudbury River watershed. However, these areas are not proposed in any of the Concepts to be connected directly to the Ashland-Framingham interceptor. They have therefore not been included for study in this report, except that data for Westborough has been included in Table 2 and in Appendix Tables.

The general pattern of the land-use impact that would result from the proposed extensions of sewer interceptors into this sub-area from Ashland-Framingham shows that they would play somewhat more of a role in enhancing and enabling growth than was true in the Upper Charles River sub-areas; i.e., since the potential growth in this corridor is greater, the "triggering effect" of the sewer interceptors will be correspondingly greater.

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[1]Except where lack of feasible alternatives justified force mains.

Hopkinton

% Developable Land Sewered in 1970: 0

1970-1990 Projection

Increase in "used" land: 1128 acres
Increase in "sewered" land: 2307 acres

Hopkinton is projected to have an eight-fold increase in employment over the 1970-1990 period, from 769 in 1970 to 6487 in 1990. The increase of 5718 employees is comparable in absolute terms to the projected increases in Ashland and Framingham, but is much greater in percentage terms and will result in a much greater observable change in the character of land use in the Town. Of these 5718, an increase of 3529 employees is projected to occur in commercial employment, with a corresponding increase of 236 "commercial" acres, more than in any other community in the sub-area.

The Comprehensive Plan prepared for the Town by the State Department of Community Affairs (August 1974) suggests that "a staged plan of sewer construction might take the following form:

(1) sewering the center within the next five years;
(2) extending the system to the Lake Maspenock area within the next 10 years;
(3) extending the system to Woodville within the next 20 years; and
(4) possible extension to East Hopkinton in the distant future."

The DCA Plan does not project a great expansion of retail activities in Hopkinton, but suggests that gradual growth of existing retail areas will occur instead. On the other hand, the Plan notes that there has been a recent upsurge in commercial (office) employment.

The total increase in net commercial and industrial acres, 1970-1990, is projected to be 350 acres, more than for any other community in the sub-area. Since this kind of large-scale development is relatively dependent upon sewerage, this suggests that in terms of industrial and commercial land use the impact of the proposed

interceptor upon Hopkinton is projected to be greater than for any other community in the sub-area.

The substantial projected increase in employment opportunities in the Town, 1970-1990, would also lead to additional pressures for more housing and community facilities in the future.

Marlborough

% Developable Land Sewered in 1970: 22%

1970-1990 Projection

Increase in "used" land: 1024 acres

Increase in "sewered" land: 2975 acres

The City of Marlborough is presently served by two treatment plants, one in the eastern part and one in the western part of the City. The City has upgraded the eastern plant. Concept 1 (only) proposes an interceptor sewer leading to this plant from Southborough.

It would appear that no new areas of the City of Marlborough would be sewered as a result of the Southborough interceptor (Concept 1) that would not have been sewered in the absence of this interceptor.

As in Ashland and Framingham, the impact upon the City from the interceptor would be the possible increased intensity of development along the interceptor corridor.

Southborough

% Developable Land Sewered in 1970: 0

1970-1990 Projection

Increase in "used" land: 490 acres

Increase in "sewered" land: 2390 acres

Routes 495, 9 and 90 (Mass. Turnpike) all run through Southborough. In spite of its favorable location, and perhaps because of the lack of good access to these highways, Southborough had only 25 acres devoted to industry in 1960, 31 in 1970, and was projected to have only 62 in 1990, a gain of 31 in twenty years. The proposed areas for sewering in Southborough consist almost entirely of developed or developing residential areas. A major industrial park-shopping center complex which was proposed in the 1962 Comprehensive Plan (Adams, Howard and Greeley) along Route 9 near Route 495 is not included in the suggested area for sewering. (It should be noted that the 1962 Plan commented that 300 to 500 acres "might" be developed for industrial use in the Southborough-Westborough area by 1970.)

Areas proposed for sewering which are now vacant (1969) seem reasonably related to existing residential areas and do not seem to encroach on wetlands.

The projected impact of the proposed sewering plan does not therefore appear to include any significant land use changes in the Town.

The above conclusions are based upon the assumption that the areas to be sewered within Southborough are the same for all four Concepts. In Concept 1 (only) an interceptor is shown leading north from Southborough to the East Marlborough treatment plant. The other Concepts show an interceptor leading east into Framingham.

Interceptor Corridor

As in the Upper Charles River sub-area the interceptor corridors would be subjected to greater development pressures than other areas. These corridors lie primarily in Framingham and Ashland, with a smaller corridor in Marlborough.

In Concepts 2 and 4, a much longer segment of the Sudbury River would coincide with the proposed interceptor corridor.

The concentrating impact of the proposed interceptors would probably be greatest in Ashland and Framingham because of their proximity to the Mass. Turnpike and potential for apartment development if current moratoria are lifted. Large-scale developments have, however, also been proposed for Marlborough, and construction of an interceptor and expanded STP there could also trigger major development in that City.

TABLE 3.3

SUMMARY: PROJECTED LAND USE CHANGES
HOPKINTON-MARLBOROUGH, SOUTHBOROUGH SUB-AREA
1970 - 1990, EMPIRIC MODEL (IN ACRES)

	TOTAL USED	NET RES.	NET COMM.	NET IND.	TOTAL "COMMITTED"	STS & HWYS	OPEN SPACE	TOTAL SEWERED	RATIO OF CHANGE IN TOTAL "USED" TO CHANGE IN TOTAL "SEWERED"
ASHLAND	+ 975	+ 680	+ 196	+ 99	+ 172	+ 130	+ 42	+ 4342	0.22
FRAMINGHAM	+ 1572	+ 1311	+ 172	+ 89	+ 254	+ 192	+ 62	+ 1393	1.13
HOPKINTON	+ 1128	+ 780	+ 236	+ 113	+ 201	+ 151	+ 50	+ 2307	0.49
MARLGOROUGH	+ 1024	+ 754	+ 145	+ 124	+ 180	+ 134	+ 46	+ 2975	0.34
SOUTHBOROUGH	+ 490	+ 437	- 5	+ 31	+ 83	+ 56	+ 27	+ 2390	0.20
WESTBOROUGH	+ 953	+ 726	+ 99	+ 129	+ 166	+ 122	+ 44	+ 5167	0.18
TOTAL FOR THIS SUB-AREA	+ 6142	+ 4688	+ 843	+ 585	+1056	+ 785	+271	+18574	0.33
TOTAL FOUR TOWNS WITHOUT ASHLAND AND FRAMINGHAM	+3595	+2697	+ 475	+ 397	+ 630	+ 463	+167	+12839	0.28

3.4.4 Increased Land Values in Intercepter Corridors

An interceptor corridor is that area within which, if a new intercepter were constructed, it would be feasible to develop multi-family housing, major commercial facilities, or light and heavy industry.

There is also a larger area in which construction of an interceptor might lead to additional provision of sewerage for single-family residential areas, connected to the interceptor. However, this larger area is not considered to be a part of the "interceptor corridor", since it would be relatively insensitive to the precise location of the interceptor, i.e., it would comprise a service area for sewering regardless of the location of an interceptor.

The maximum width of an interceptor corridor can be considered to be roughly that area within about two miles of an interceptor. Within this distance, local cities and towns may consider undertaking the financing and construction of connections to an interceptor that would be adequate to service large industrial or commercial complexes that would provide substantial returns to the tax base. The range within which such new connections would be undertaken to service multi-family housing would be smaller, and would decrease with the size of the potential development.

Within an interceptor corridor, the provision of an interceptor would be only one of many factors affecting land values. Other factors would be:

- sub-regional and local demand for industrial, commercial and residential (multi-family) land;
- water supply;
- transportation and accessibility;
- land suitability (e.g. parcels of suitable size, shape, location and soils for development);
- local policies and regulations such as zoning, subdivision control, off-street parking requirements, health regulations, building codes, etc.
- local taxes.

In spite of the fact that all of these factors taken together help to determine land values, and that sewering alone is difficult to

isolate in terms of its impact on land values without knowing the conditions of particular sites in question, a very rough estimate has been made below of the magnitude of this impact. The procedure used has been as follows:

1. Based upon the Empiric Model (High) projections to 1990, identify the additional amount of land expected to be used for residential, commercial and industrial purposes (in those communities covered in the "land use" section of this report).
2. Estimate the proportion of this increment that could probably be attributed to new interceptor lines, excluding single-family acreage and acreage that might be developable on the basis of existing sewerage systems.
3. Multiply the developed acreage attributable to the interceptors by a dollar estimate of the increased land value for that particular type of land use that could be the result of sewering. These dollar values are in terms of 1975 dollars, although actual development would occur over the 15 year period to 1990. Incremental values attributable to sewering have been estimated within roughly the range of $4,000 to $12,000 per acre, depending upon local demand, current availability of existing sewerage, and type of use involved.

The results are shown in Table 3.4 following.

TABLE 3.4

EXPECTED CHANGES IN LAND USE (1970 - 1990 HIGH) AND LAND VALUES

	ACTUALLY USED ACRES*			
	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	INCREASE IN AGGREGATE LAND VALUE ATTRIBUTABLE TO SEWER INTERCEPTOR (ESTIMATED)
Bellingham	+ 322	+ 67	+ 50	$ 330,000
Franklin	+1,130	+ 87	+ 66	1,680,000
Holliston	+1,067	+ 89	+ 56	1,300,000
Medfield	+1,294	+102	+119	1,200,000
Medway	+ 422	+115	+ 61	840,000
Milford	+ 303	- 28	+ 19	-
Millis	+ 714	+ 88	+ 24	300,000
Wrentham	+ 708	+ 72	+ 60	1,020,000
Ashland	+ 680	+196	+ 99	2,800,000
Framingham	+1,311	+172	+ 89	3,920,000
Hopkinton	+ 780	+236	+113	1,760,000
Marlborough	+ 754	+145	+124	3,700,000
Southborough	+ 437	- 5	+ 31	120,000
Westborough	+ 726	+ 99	+129	2,100,000

*SOURCE: Metcalf and Eddy run of Empiric Model. Full results are shown in Section 11 (Appendix)

3.4.5 **External Impacts**

Lower Charles River Basin

Extending sewer interceptors into the upper reaches of the Charles River Basin will upgrade the water quality in the River. Along with other efforts to upgrade the Charles River Basin both aesthetically and for recreational use, this will reinforce the trend toward more intensive residential and office development along the riverbanks downstream.

At the same time, the purer river will be increasingly desirable for recreational use. However, without public intervention, market competition will tend to result in more intensive development displacing recreational use. Areas that might be especially affected would be Watertown, Newton and Waltham.

Metropolitan Densities

As with all suburban development, sewering additional suburban areas will tend to contribute to the lowering of population and employment densities in the more concentrated parts of the Metropolitan Area. This in turn will result in some decrease in demand for and utilization of housing and more centrally-located services and facilities, public and private. The degree to which this would also have occurred in the absence of some incremental suburban sewering, however, is not predictable given the existing information.

Opportunities Foregone

In the very broadest sense, the impact of any given concept must also be viewed in terms of land use and housing in areas in which investments will not be made in new or improved interceptor sewers and treatment plants. Adoption of any of the existing Concepts, for example, would exclude the possibilty of connecting Foxborough by force main into the MSD system. (This alternative was included in the Camp, Dresser & McKee study.)

The effect of not making such a connection depends upon the alternatives that may be available to Foxborough instead. Located at the junction of Routes 95 and 495 in a growth corridor, the Town would seem to be a desirable area for sewering in terms of overall economic development strategy.

If alternative sewering plans for Foxborough are not funded and pursued, important development opportunities in the Town may not be realized, or may be significantly delayed.

Change in Water Level/Stream Flow

Changes in water levels or stream flows in various rivers and other water bodies as a result of parallel sewering may result in some changes in land uses and housing along these waterways. If large decreases in stream flows should occur, for example in a relatively small river system, such an area may lose some of its appeal with consequent potential loss of property values in nearby areas.

Lower stream flows could also result in loss of certain recreational opportunities such as boating. Lower (and purer) stream flows may therefore have at least some disadvantages as compared with higher but more polluted stream flows. (See footnote 1 to Section 2.1.2.)

4.0 HOUSING

4.1 Introduction: Summary of Findings and Conclusions

As with land use in the proceeding chapter, the estimated impact upon housing of the proposed alternative concept plans for extension of sewer interceptors has been limited to the Upper Charles River sub-area and the Hopkinton-Marlborough-Southborough sub-area.

Estimating the impacts of these alternative proposals upon a particular use such as housing is hazardous, and these impacts must be considered as probabilities, not as certainties. It is impossible to conclude, for example, that apartments or moderate-income housing will not be built if interceptors are not extended. Alternative local sewerage systems may be developed by the community, or on-site disposal may be permitted for small developments. Conversely, residents of a community that is sewered may continue to resist low and moderate income housing, in spite of the fact that lack of sewerage had previously been cited as the principal reason for opposition. The method that has been used in this study is to develop criteria for evaluating the probable impacts of projects, and then describe in general terms the direction in which it seems the project might have an impact, if known, with respect to each of these criteria.

Summary of Findings and Conclusions

1. In relatively unsewered areas which lie in rapid growth corridors, such as Westborough and Hopkinton, the potential impact upon residential growth can be large. The new interceptors could exercise a "triggering" effect upon future residential development. The same effect can occur in Marlboro and Framingham as capacity is upgraded, even though these communities already have substantial sewerage systems.

2. In an area experiencing less rapid growth, the Upper Charles River sub-area, sewering will upgrade the quality of existing residential areas and contribute to improved community health over the long run, but will have less of an effect upon triggering growth. (Much of the expected growth in this area is attributable to one-family units with on-site sewage disposal).

3. Local zoning and other policies will have a greater influence with regard to growth, new construction, and low-and-moderate income housing than presence or absence of sewer interceptors per se. However, availability of sewerage will probably mitigate to some extent the weight of this reason for not constructing new low and moderate income housing.

4. In the long term, extension of sewer interceptors tends to make suburban areas more suitable for continued residential development. The causality of this relationship also operates in the other direction, however; i.e., continuing residential development in suburban areas eventually results in population and political strength in these areas which in turn can increase the probability that sewers will be built. Each proposed extension is therefore only one step in a continuing process of incremental development.

4.2 Criteria for Evaluation

1. Health. Would the proposed project help to meet community health needs by providing otherwise unavailable sewering to existing residential areas that a) already have sanitary problems; or b) otherwise are likely to have such problems within the next 20 years?

2. Satisfying Housing Demand. Would the proposed project make it possible to satisfy some residential demand in this area (for single-family or multi-family units) that would otherwise not be possible to meet as well? (E.g., location vis-a-vis jobs, transportation, etc.?)

3. Low and Moderate Income Housing Needs. Would the proposed project directly or indirectly increase the probability that the needs of the community and larger region for low-and-moderate income housing will be met? (See Table 4.1 for estimated local housing needs.)

4. Development Strategy, Timing and Coordination. Would any changes in the housing pattern in the region or community that might result from the proposed project be compatible with currently accepted local and regional development strategies, including:

TABLE 4.1

LOW AND MODERATE INCOME HOUSING NEEDS

Housing Need and Housing Effort, April 1970 and December 1972, by Age of Household Head and Income, for Cities and Towns.

(Source: 1974 Report on Housing Needs and Programs, Final Review Draft, March 1974, Mass. Dept. of Community Affairs)

LOCALITY	** ASHLAND	BELLING-HAM	** FRAMING-HAM	FRANK-LIN	HOLLIS-TON	HOPKIN-TON	MARL-BOROUGH	** MED-FIELD	MED-WAY	MIL-FORD	** MILLIS	SOUTH-BOROUGH	** WEST-BOROUGH	WRENT-HAM
Total Year-Round Units, April 1970	2529	3644	19,439	4489	3241	1752	8821	2380	2144	6189	1551	1615	3330	1648
Housing Need April 1970 Total	427	448	3,577	703	460	356	1811	387	365	1309	232	298	687	360
Elderly, Low Inc.	152	169	1,087	211	127	129	655	138	149	594	86	107	247	131
Elderly, Mod. Inc.	22	11	242	29	36	23	104	39	19	61	12	10	53	22
Non-Eld., Low Inc.	198	233	1,731	384	228	134	825	148	154	552	105	151	297	169
Non-Eld., Mod. Inc.	49	75	517	79	69	70	227	62	43	102	29	30	90	38
Housing Effort to Date, Dec. '72 Total	40	113	1,584	244	48	92	303	40	101	763	72	--	54	66
Elderly, Low Inc.	40	112	429	128	48	92	102	40	94	180	72	--	40	66
Elderly, Mod. Inc.	--	---	---	---	--	--	---	--	--	---	--	--	0	--
Fam. & Mixed, Low	--	---	390	100	--	--	2	--	7	330	--	--	14	--
Fam. & Mixed, Mod.	--	1	765	16	--	--	199	--	--	253	--	--	0	--
Effort to date as % of 1970 Units	1.58	3.10	8.15	5.44	1.48	5.25	3.43	1.68	4.71	12.33	4.62	--	1.62	4.00
Net Effort, April '70 to Dec. '72 Total	40	112	509	136	48	60	201	40	67	582	40	--	40	66
Elderly, Low Inc.	40	112	204	48	48	60	--	40	60	69	40	--	40	66
Elderly, Mod. Inc.	--	---	---	---	--	--	--	--	--	---	--	--	--	--
Fam. & Mixed, Low	--	---	80	72	--	--	2	--	7	260	--	--	--	--
Fam. & Mixed, Mod.	--	---	225	16	--	--	199	--	--	253	--	--	--	--
Net Housing Need, Jan. '73-Total	387	376	3,068	567	412	296	1610	347	298	878	192	298	647	294
Elderly, Low Inc.	112	57	883	163	79	69	655	98	89	525	46	107	207	65
Elderly, Mod. Inc.	22	11	242	29	36	23	104	39	19	61	12	10	53	22
Fam. & Mixed Low*	198	233	1,651	312	228	134	823	148	147	292	105	151	297	169
Fam. & Mixed Mod.	49	75	292	63	69	70	28	62	43	--	29	30	90	38

* A number of units classified here as family and mixed actually have elderly living in them. An estimate was made of this for each region; however there was not sufficient data to adjust these city and town figures. Net housing need for families may therefore be greater than indicated here.

** City or town within a metropolitan area (SMSA).

*** Central city of a metropolitan area.

- preservation of open space, environmental and historic resources, wetlands and flood plains;
- economic development strategy;
- regional plan for distribution of residential densities;
- regional transportation strategies;
- local community facilities plans?

5. Private Residential Property Values. Would the proposed project contribute to the value of existing private residential development or potentially residential undeveoped vacant land? Would this encourage housing rehabilitation and maintenance efforts?

6. Potential Inequities. Are there potential inequities that would arise (or be mitigated) in connection with changes in housing that might result from this project?

Hopkinton-Marlborough-Southborough Sub-Area

Ashland

Ashland is projected to have a large increase in "% sewered of total developable acres", from 3 percent in 1970 to 70 percent in 1990, but only a modest increase in "% used of total developable acres", from 17% in 1970 to 32% in 1990, indicating that the expected impact of sewerage in this community is not likely to be great in terms of immediately triggering new residential development.

"Ashland has some new apartment construction, but has had a very low growth rate. Apartments are restricted to specific areas; zoning regulations to control garden apartments failed to pass the Town Meeting in 1972; and in the future, apartment activity is likely to increase somewhat. Minimum lot sizes are 30,000 and 20,000 square feet. In many ways a typical suburban community, Ashland has a large school-age population."[1]

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[1] Source: Mass. DCA, Comprehensive Plan for Hopkinton, Mass., August, 1974.

Because of the regionally estimated strong demand for growth in the number of apartment units, construction of an interceptor could tend to concentrate any such new construction in or near the interceptor corridor, as well as increase somewhat the total number of units eventually built in Ashland.

Concentration of apartment units in and near the Mass. Turnpike growth corridor coincides with regional development plans.

Additional burdens would be placed on local community facilities such as schools and the local street system.

According to the Mass. DCA, there was a "net housing need" of 387 units of low and moderate income housing in Ashland in January 1973. A new interceptor could reduce community opposition to the construction of new low and moderate income housing, especially since only 3% of all developable land was sewered in 1970.

Sewerage extension in Ashland would primarily serve existing as opposed to new residential areas and the principal benefit would therefore be in terms of long-range community health.

Framingham

"Framingham has a relatively high median income, a small proportion of owner-occupied housing units, and high value of housing. It has experienced a large increase in population over the past decade (43.7%) and has seen the construction of 10,167 dwelling units over the period 1961-1971. The population increase has been primarily in school-age and middle-age groups. Framingham's stock of muiti-family dwelling units and its large commercial and industrial developments characterize it as a suburban growth satellite. Along with Marlboro, it is becoming a prime location for young working couples seeking apartments, especially those willing to commute longer distances to work. Apartment construction, though temporarily halted, is likely to resume in the long range future. Framingham has minimum lot sizes of 43,560 square feet, 20,000 and 8,000 in residential areas."[1]

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[1] Source: Mass. DCA, Hopkinton, op. cit.

Although the demand for apartments in Framingham may continue to be strong in the future, the location of the proposed new interceptors is unlikely to have much effect upon the future pattern of development, since in 1970, 78 percent of the total developable land in Framingham was already sewered according to the M&E report. Whatever additional development that does occur would be in general conformance with regional growth strategies of encouraging a variety of housing types concentrated in "growth corridors" and convenient to transportation and jobs.

Although most of Framingham is currently sewered, provision of an interceptor that assured additional capacity in the future could reduce some opposition to meeting the town's low and moderate income housing needs, which are the largest in the study area (3,068 units).

Hopkinton

"The housing stock in Hopkinton is relatively old but not necessarily in poor condition. Although the 1970 Census of Housing did not include an indicator of housing condition, the 1960 Census did demonstrate that as much as 16.2% of all housing was deteriorating or dilapidated. Most of this housing is located in the more isolated rural areas, and includes some old seasonal units." Eighty percent (80%) of all housing units are owner-occupied. According to Hopkinton's Asst. Assessor the mean value of housing is around $28-30,000.

"Only 18% of all structures in the town were built between 1960 and 1970. A relatively large proportion of the population has lived in the town over a long period of time."

An analysis of building permits over the past five years indicate an increase in activity over the last two years:

AD-A036 810 METCALF AND EDDY INC BOSTON MASS F/G 13/2

WASTEWATER ENGINEERING AND MANAGEMENT PLAN FOR BOSTON HARBOR - --ETC(U)

OCT 75

UNCLASSIFIED NL

2 OF 3

AD A036810

Year	Building Permits Single-Family	Multi-Family	Total Value of Construction
1968	23	-	$ 535,255
1969	17	-	634,055
1970	15	-	246,700
1971	40	126**	1,472,051
1972	100	-	1,254,345*

* Does not include alterations.
** 60 of these are elderly housing.

It should be noted that these figures reveal only the number of permits issued, not the number of structures actually built. However, it is likely that most owners with permits have decided to build."[1]

The empiric model has shown a fairly limited projected increase in households in Hopkinton during the period 1970-1990, even with the assumption that sewerage would be provided.

The principal benefit in Hopkinton of sewerage would be expected to be in terms of community health, especially for some older seasonal units if these areas are sewered in the future.

The town has a low-and-moderate income housing "need" of less than 300 units, and has recently built 60 units of elderly housing. Provision of interceptors in the future to Hopkinton would probably have only a slight impact on changing local capacity to meet regional needs for low and moderate income housing.

The model projects a substantial increase in employment in Hopkinton by 1990. Additional housing demand would be created by such employment, and this could be expected to be realized to some extent after 1990.

Marlborough

"The amount of land in residential use has increased 27.3

[1] Source: Mass. DCA, op.cit., Hopkinton.

percent since 1962. According to the 1962 Master Plan, 1,477.8 acres were devoted to residential use, in 1973 this figure had increased to 1880.6 acres.

Single family dwelling units constitute the largest element in the residential land use category. In 1973, the 4,873 single family units in the City covered 1546.3 acres of land. Most single family construction since 1962 has taken place in the northeastern section of Marlborough. Large subdivisions have been built in the area around Miles Standisch Drive near Fort Meadow Reservoir and south of Concord Road in the Symphony Road-Harmony Lane area. New homes are now being constructed in the northeastern section in three separate subdivisions: (1) Hillcrest Estates (53 lots), (2) Meadowbrook Village (33 lots) and (3) Woodland Estates (48 lots).

A new single family development has also been constructed in the southwestern section of the City adjacent to the West Elementary School.

Reservoir Ridge, a subdivision comprising 33 lots, in the southern section of the City off Framingham Road has Planning Board approval.

All totaled, 829 units of single family housing were constructed in Marlborough in the ten year period from 1963 to July 1973. The pattern of construction tapered off in 1970 and 1971 but increased again in 1972 and during the first six months of 1973.

The market for single family housing in Marlborough will continue to generate a demand for further construction.

Two family and multi-family--two and three deckers--housing occupies 152.6 acres of land in Marlborough. Most of these structures are located on the fringe areas of the Central Business District.

__Apartments__

There has been a tremendous boom in apartment construction in Marlborough in the past decade. From 1963 to the beginning of 1973, 2,172 apartment units were constructed in the City. This is over

two and a half times the number of single family dwelling units constructed in the same period. In 1973, apartment units constituted 21 percent of all year-round dwelling units in the City.

Most of the apartment complexes have been erected along the eastern section of Route 20, stretching to beyond Wilson Street. Two large apartment complexes--Royal Crest and Brook Village--are situated on both sides of Hosmer Street, north of Route 20. A very large complex of apartments--Chateau Marlborough (264 units) is located off Broadmeadow Street.

The 2,196 apartment units built in Marlborough, since 1960, cover a total of 153.5 acres of land. This yields a density of 14.3 dwelling units per acre.

The apartment boom in Marlborough appears to have tapered off. The City's revised zoning ordinance includes more stringent provisions regarding apartment construction.

State law provides a three-year extension period for construction under previous zoning regulations. During this extension period, 32 apartment buildings containing 1,121 dwelling units were constructed. Since the three-year extension period expired in January 1972, no building permits for apartment construction have been issued."[1]

As discussed in the "land use" chapter, Marlborough is already serviced by local treatment plants. Extension of interceptors to Marlborough is likely therefore to substitute for some expanded local plant capacity, and the pattern of future residential development may not vary significantly from what might be expected in the absence of such interceptors. Such an expectation is not a certainty, however. If demand continues to remain strong in this area, past proposals for large new residential developments in Marlborough may be revived, and in this case their approval by local authorities would probably come more readily if the required additional sewerage capacity were going to be provided by MDC interceptors instead of through

[1]Source: Mass. DCA. Comprehensive Plan for Marlborough, March 1974.

locally financed expansion of existing plant capacity.

The estimated need for low and moderate income housing in Marlborough is substantial (1,610 units). Again, however, the current availability of sewerage in the City would indicate that a new interceptor would produce little change in the City's ability to meet these needs in the future.

Southborough

Southborough is in the process of organizing a housing authority for the purpose of providing elderly housing forpersons of low income. Nevertheless, it will probably maintain its character as a high-income suburb with relatively low residential densities, unless there are unforeseen changes in land use policy in that town. There are no provisions for apartments and low-density subdivisions will probably continue at a moderately rapid pace. Minimum lot sizes are 25,000 and 43,560 square feet.

"Southborough presently has no provision in its zoning ordinance for apartments, even though it is located strategically adjacent to Framingham, Marlborough and Westborough."[1]

Proposed areas to be sewered are almost entierely limited to existing residential areas, and future interceptors are therefore not expected to significantly alter the existing development pattern in the Town.

Westborough

"Westborough has had a large increase in the construction of multi-family dwelling units. There has been some garden apartment development, and apartments are not permitted in industrial B and business districts. Although Westborough's population has increased by only 30.6% over the last decade, there have been 2,118 building permits issued for multi-family dwelling units. Minimum lot size in Westborough is 15,000 square feet."[2] Attempts are now being made to

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[1] Source: DCA. Hopkinton, op. cit.

[2] Ibid.

change Westborough's policy toward apartments.

Demand pressures are likely to continue in this area, and provision of sewerage is therefore likely to enable and trigger additional multi-family development in the future.

Upper Charles River Sub-Area

Bellingham

Sewering in Bellingham will primarily serve already built-up areas. Little growth is expected in the Town in the future. The principal benefit of sewering in Bellingham will be in terms of long-term community environmental health in existing residential areas.

Franklin

Franklin has the largest projected growth in households, 1970-1990, of any Town in the Upper Charles sub-area. As noted in the land use section, however, much of this growth is expected to occur in single-family areas where on-site sewerage would be (have been) feasible, so the triggering effect of interceptors is considered to be only modest.

Holliston

"Holliston has had a large percentage of population growth over the years 1960-1970 (94%). It is characterized by a high income population with owner-occupied housing of relatively high value. Holliston has an apartment complex, and its zoning allows for multi-family dwelling units in residential districts by special permit. Minimum lot size is 20,000 square feet, though the average single-family home lot is over 30,000 square feet. Holliston is rather similar to Southborough in character and appears to have a great deal of potential for increasing low-density residential development; the physical obstacles to development, however, are similar in many respects to those in Hopkinton."[1] The principal areas proposed for

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[1]Source: Mass. DCA, op. cit., Hopkinton.

sewering in Holliston are already developed, primarily single-family residential areas.

Even though apartments are permitted by special permit, it is not anticipated that a large number of units will be built in the Town in the future, due to the restrictiveness of the permit provisions.

It is expected that since the Town has a relatively modest estimated housing "need" of 412 units of low and moderate income housing, and the Town was 0% sewered in 1970, provision of sewerage might play a significant role in permitting the Town to meet this need in the future.

Medfield, Medway, Millis and Wrentham

In all four of these Towns sewering could contribute to some additional residential growth, especially in Medfield where soils are least suitable for on-site sewage disposal. Growth in Medway is expected to be small, however. In all four Towns, gradual encroachment of residential areas on sensitive wetlands is predictable.

Milford

"Milford has an older housing stock, low median income and large young population; however, over the last few years, the town has experienced a rapid increase in multi-family dwellings which promises to drastically alter the character of the community. Population increased by only 22.9% over the decade of 1960-1970, but has since advanced at a more rapid pace. Multi-family dwellings are permitted in general residential districts and by special permit in other districts; however, there are severe problems with existing apartments due to lack of adequate waste water facilities. Minimum lot sizes are 15,000 square feet in single-family zones, 30,000 in rural residential and 8,000 in general residential zones."[1]

Since Milford already has an extensive sewerage system (although, as noted above, some sections are inadequate) construction

[1] Source: DCA Hopkinton, op. cit.

of an interceptor is expected to have only amodest affect upon triggering future growth. The following table summarizes expected impacts of proposed interceptors with respect to housing. The table shows, to the extent possible, the marginal changes in expected trends that could be attributed to the interceptors, not simply the direction of future trends themselves. For example, a community which has well drained soils and is located in a "growth corridor" may experience rapid growth whether or not sewerage is provided. In other Towns an interceptor may provide little or no benefit to the Town's residential areas, but will help clean up a river and thereby benefit downstream areas. In communities where lack of adequate sewerage is a major bottleneck to growth, interceptors can be expected to trigger significant additional development.

Table 4.2: Estimated Significant Housing Impacts of Proposed Interceptors, by Area, by Criteria

	Helps Meet Community Health Requirements in Residential Neighborhoods	Helps Satisfy Housing Demand		Could Facilitate New Low and Moderate Income Housing	Encourages Development Compatible With Regional Growth Strategy
		One-Family	Multi-Family		
ASHLAND	++	+	+	+	+
BELLINGHAM	++	0	0	+	0
FRAMINGHAM	+	0	++	+	+
FRANKLIN	+	+	+	+	+
HOLLISTON	++	0	+	+	0
HOPKINTON	++	+	0	+	0
MARLBOROUGH	+	+	++	+	+
MEDFIELD	++	+	0	+	+/-
MEDWAY	++	0	0	+	+/-
MILFORD	0	0	0	+	0
MILLIS	++	+	0	+	+/-
SOUTHBOROUGH	++	0	0	+	0
WESTBOROUGH	++	+	+	+	+
WRENTHAM	+	+	+	+	+

++ = Significant Positive

\+ = Some Positive

0 = Little or No Impact

\- = Some Negative

-- = Significant Negative

SUMMARY: Projected Increase In Households, 1970 (Actual) to 1990 (High Projection)

ASHLAND	+ 1784
FRAMINGHAM	+ 5494
HOPKINTON	+ 1458
MARLBOROUGH	+ 2808
SOUTHBOROUGH	+ 1145
WESTBOROUGH	+ 1909

BELLINGHAM	+ 724
FRANKLIN	+ 2104
HOLLISTON	+ 1590
MEDFIELD	+ 1937
MEDWAY	+ 933
MILFORD	+ 943
MILLIS	+ 1563
WRENTHAM	+ 1322

5.0 INDUSTRIAL ACTIVITY

5.1 Major Findings and Conclusions

1. Five industry categories in the EMMA study area will bear the major burden of industrial costs associated with implementing any of the five proposed engineering concepts: paper, metals, chemicals, textiles, and food processing. Major discharger (more than 50KGD) in these categories currently account for 55,500 jobs.

2. Estimated percentage increases in product prices which would be attributable to added treatment costs in these industry categories are relatively low (less than 1%), except for paper products when it could be as high as 8.6%.

3. The resulting estimate of the maximum number of 1977 jobs which would be lost because of the additional costs of wastewater treatment to these industries is also low, 155 jobs.

4. Given the roughly comparable total costs of the five engineering concepts, the analysis cannot usefully discriminate among them regarding industrial job losses. If a preference ordering is called for, the only reasonable one would be one based on total costs.

5.2 Analysis

This section examines the likely impact of carrying out the wastewater treatment plans on firms in the manufacturing sector. The general intent of the relevant legislation is that industry will carry a share of the cost of achieving clean water proportional to its contribution to the pollution problem. Whether the cost to industry is incurred in the construction of industrial treatment plants, changes in processes or products to achieve lower effluent discharges, or payments to municipal treatment systems in the form of user charges is of minor significance in assessing the effects of the extra cost on the economic viability of the industry.

The present assessment focuses on the likely impact of the cost to industry of complying with the law by using public wastewater treatment facilities. This scenario assumes that all manufacturing firms will participate in the public treatment system. The analysis of the possible effects of alternative mixes of private and public facilities is hampered by the complexity of industrial treatment alternatives and the variability of associated cost estimates. This restriction of the assessment is reasonable, since the main concern is the <u>maximum impact</u> of wastewater treatment requirements. It is unlikely that industry would construct private facilities if they were more expensive than participation in the public system. The assumed scenario therefore is the <u>highest-cost</u> alternative for manufacturing firms.

Participation in public treatment systems generates costs to industry in a number of ways:

- Cost of construction of treatment facilities for pretreating industrial wastes to make them compatible with municipal wastes;
- cost of operating pretreatment facilities;
- payment of a proportionate share of the capital cost of public treatment facilities financed by Federal funds (75% of the total);
- payment of user charges to cover a proportionate share of the annual O&M and debt service costs.

These factors increase the cost of production in a given industry in direct proportion to the amount of effluent discharges and the severity of pollution. The principal issue in the impact assessment is the way in which these cost increases affect the economic viability of the firm. If cost increases are passed on to the consumer, the quantity of output demanded is likely to decrease, resulting in production cutbacks and a displacement of jobs in that industry. The extent to which such effects are felt depends primarily on the price elasticity of demand for the goods produced by that industry.

A frequently mentioned concern with respect to the enforcement of water pollution legislation is the impact on industry mobility. If there are significant differences among regions with respect to water pollution control costs, industries may leave regions with higher costs. However, this problem is of little significance if water pollution control legislation is enforced on a nationwide basis as stipulated in PL 92-500. The design of the Act is such that financing mechanisms and effective costs to industry will not differ significantly from one region to another.[1] It is therefore unlikely that one region will lose industry to another as a result of implementing the advanced wastewater treatment system. For the purpose of analysis here, it has therefore been assumed that out-migration of industry will not occur. Neither will industry in the study region worsen its competitive position vis-a-vis industry in other regions. Therefore, price elasticities for the national industry could be used to determine the impact of any price increases on production and employment.

METHODOLOGY

The present analysis is designed to provide a broad assessment of the likely impact of implementing wastewater treatment plans on

[1] The recent oversight hearings for PL 92-500 showed the municipalities' concern with being able to use alternative financing mechanisms as a means of maintaining the option to subsidize certain industries. In response to these concerns, EPA indicated greater flexibility (e.g. allowing for ad valorem taxes combined with surcharges). However, a recent report from GAO has reemphasized the legislative intent to establish a financing scheme that will charge industry in direct proportion to its contribution to the pollution problem.

industry in the region. This assessment should focus on the most significant components of the problem rather than attempt to generate impact estimates for all components of industry. Neither the methodology nor the available data allow for reliable estimates for all firms.

The selection of the analytical focus is based on the industry survey conducted by Jason M. Cortell & Associates for the Army Corps of Engineers. The data collected in this survey constitute without doubt the most comprehensive information base for examining the impact of wastewater treatment costs on manufacturing industries. However, the design of the study makes it impossible to define the degree to which industrial activity in the study region is in fact covered. A check against other data sources (e.g. Census publications) is impossible, since employment in the latter is categorized by residence rather than place of work. The following analysis should therefore be interpreted as conceivable covering only parts of the overall problem.

Table 5.1 presents an overview of the current and predicted wastewater flows generated by industry. In 1973, five industries accounted for almost 80% of the total industrial wastewater flow. This percentage is projected to decline until 2050 as a result of reductions in total production as well as technical improvements that are expected to lower the wastewater load per unit of output. By interpolation (assuming constant annual growth rates for each of the subperiods) approximate wastewater discharges can be estimated for each of the intervening years in each industrial category.

Another focus for the analysis can be established by examining the relative contribution of the heaviest discharges to the total industrial wastewater flow. The analysis of individual firm data provided in the Cortell study indicates that 99% of the total industrial waste-water flow are accounted for by 95 firms, each discharging more than 50,000 gallons per day. As indicated in Table 5.2 the concentration is strongest in the paper industry (SIC 26) where four firms with less than 8% of the total employment account for 100% of wastewater discharges, and in the textiles industry, where eight firms with a little over 40% of total industry employment account for all discharges.

Table 5.1 <u>CURRENT AND PROJECTED INDUSTRIAL WASTEWATER</u>

		DISCHARGES (in Thousand Gallons per Day)*			
SIC	Industry	1973 (%)	1990 (%)	2020 (%)	2050 (%)
20	Food	7,880 (23.0)	8,670 (25.8)	11,030 (23.2)	11,820 (23.4)
22	Textiles	2,100 (6.1)	1,680 (5.0)	1,260 (2.6)	1,050 (2.1)
26	Paper	5,170 (15.0)	5,690 (16.9)	8,760 (18.4)	9,820 (19.5)
28-30	Chemicals	10,090 (29.5)	8,070 (24.0)	12,110 (25.4)	12,110 (24.0)
33-35, 37	Metals	1,900 (5.6)	1,710 (5.0)	1,710 (3.6)	1,520 (3.0)
--	Other	7,070 (20.7)	7,780 (23.2)	12,730 (26.7)	14,140 (28.0)
	TOTAL	34,200 (100.0)	33,600 (100.0)	47,620 (100.0)	50,460 (100.0)

* For industries surveyed.

Source: Jason M. Cortell & Associates, Inc., <u>A Study of Wastes from Large Industries. Eastern Massachusetts</u> Metropolitan Area. (For: Department of the Army, New England Division, Corps of Engineers'.) May 1974. p. 55.

Table 5.2

RELATIVE CONCENTRATION OF WASTEWATER DISCHARGES AND EMPLOYMENT (1973)

					Firms Discharging More Than 50 KGD					
SIC	Industry	Number of Firms Surveyed	Total Discharge in KGD	Total Employ-ment	No.	(% of Total)	Discharge	(% of Total)	Employ-ment	(% of Total)
20	Food	37	7,880	16,678	28	(75.7)	7,840	(99.5)	13,033	(78.1)
22	Textiles	20	2,100	7,182	9	(45.0)	2,100	(100.0)	3,142	(43.7)
26	Paper	22	5,170	8,296	4	(18.2)	5,170	(100.0)	648	(7.8)
28-30	Chemicals	23	10,090	12,662	13	(56.5)	10,070	(99.8)	8,822	(69.7)
33-35,37	Metals	47	1,900	34,353	8	(17.0)	1,890	(97.9)	13,085	(38.1)
-	Other	104	7,070	59,487	33	(31.7)	6,750	(95.5)	16,770	(28.2)
	TOTAL	253	34,200	138,658	95	(37.2)	33,760	(99.0)	55,500	(40.0)

Source: Jason M. Cortell & Associates, Inc., *op. cit.*, Appendices.

In all other cases, firms with a discharge of more than 50,000 gallons per day account for more than 95% of the respective total. It is therefore permissable to narrow the range of analysis to these firms, since the major part of industrial activity included in the survey in the study region is covered.

Given the distribution of wastewater sources, it is reasonable to concentrate the analysis on the 95 firms and their employment and output to sketch the overall impact of cost of wastewater treatment. The incidence of pollution control costs for other firms will be too small to reach any reliable statements about significant impacts.

The next step in the assessment consists of estimating the likely cost of pollution control for each industry on an annual basis. According to the provisions of PL 92-500, industry is expected to pay a proportionate share of the Federal contribution to the capital cost of public treatment facilities, spread out over 30 years or the useful life of the works. In the present context, two time periods have been used, 20 and 30 years, to establish a range of annual capital costs to be paid by industry. In addition, industry is expected to pay its share of annual O&M costs and the costs of debt service for the local share of the capital costs.

In computing the relevant annual costs of the wastewater treatment system, the level of detail possible does not warrant a distinction among the five proposed engineering alternatives. The costs for these options have therefore been averaged in the analysis here. Table 5.3 presents a listing of the relevant cost elements for computing the industrial cost burden.

The total annual cost to industry attributable directly to participation in municipal treatment systems (excluding the cost of pretreatment) can be estimated by applying the projected share of industrial wastewater in the total treatment load to the annual costs for establishing and operating the treatment systems. Forecasts of wastewater loads prepared by the Army Corps of Engineers suggests an industrial share of 19.9% for the year 2000. Under the assumption that this share is an appropriate guideline for the allocation of total public costs to

Table 5.3 TOTAL ANNUAL COSTS OF PUBLIC FACILITIES

(In Million Dollars)

	Average for the Five Concepts
Total Capital Cost	1,044.0
Federal Share	783.0
Annual--20 years	39.2
Annual--30 years	26.1
Annual Debt Service for Local Share	9.7
Annual O&M Cost	19.5
Total Annual--20 years	68.4
--30 years	55.3

industry, effective costs for the major dischargers in each industry group can be computed for any year of the study period.

The analysis here uses 1977 as a focal year for assessing the likely impact of implementing the wastewater treatment program. This choice is reasonable, since 1977 -- the target date for achieving Best Practicable Technology -- is an important milestone in the time schedule established in PL 92-500. Thus, total industrial costs for this year have been allocated to each of the industrial groups in direct proportion to their contribution to the total industrial wastewater flow for the year 1977, of the 95 identified large dischargers. The results of the application of this demonstrates the maximum possible job loss impact of PL 92-500. However, since the 95 dischargers do not fully account for the total industrial waste flow, these results most likely overstate the extent of job loss. The resulting estimates are shown in Table 5.4.

For the present analysis, the most important element is the expenditures required from firms that discharge more than 50,000 gallons per day. On a per-employee basis, the costs are significantly higher, since they account for a much lower percentage of total industrial employment than total industrial wastewater discharge. The estimates are consistent with information available from other sources. The paper industry (SIC 26) is generally expected to bear the heaviest cost burden relative to overall activity levels; the chemicals industry (SIC 28) frequently shows the second-highest relative costs of water pollution control measures.

The translation of the estimated water pollution control costs, measured as the financial burden of industry associated with a policy of discharging wastewater into a public treatment system, into price and output effects is hampered by shortcomings of the data base. In the 1972 publication, The Economics of Clean Water, the Environmental Protection Agency attempted to estimate this type of impact by examining the incremental value added associated with industrial wastewater treatment costs. Industry-specific markup factors were then applied to these incremental value-added figures to determine the total price effect. The resulting price impact measures could have been divided subsequently by

Table 5.4 ANNUAL DISCHARGES AND TOTAL COST*
(Estimated by Industry for 1977)

SIC	Industry	All Firms Surveyed Discharge (in KGD)	All Firms Surveyed Total Cost ($ Million)	All Firms Surveyed Cost/Employee ($)	Firms Discharging More than 50 KGD Discharge (in KGD)	Firms Discharging More than 50 KGD Total Cost ($ Million)	Firms Discharging More than 50 KGD Cost/Employee ($)
20	Food	8,200	3.29	190	8,160	3.27	250
22	Textiles	1,920	.77	110	1,920	.77	250
26	Paper	5,380	2.15	260	5,380	2.15	3,320
28-30	Chemicals	9,200	3.69	290	9,180	3.68	420
33-35,37	Metals	1,820	.73	20	1,780	.71	50
--	Other	7,350	2.94	50	7,020	2.81	170
	TOTAL	34,000	13.57	100	33,700	13.39	240

*For 20-year time horizon, excluding pretreatment costs.

the total value of shipments by industry to determine the percentage change in prices that would be associated with the implementation of wastewater treatment efforts. Unfortunately, value-added data are not available for each individual firm included in the survey conducted by Cortell. Such data would be indespensable for examining the impact of implementing the plan alternatives on the firms most affected -- those discharging more than 50,000 gallons per day.

However, it is possible to compute appropriate proxy measures to obtain at least a general feeling for the magnitude of the potential employment impact. We have imputed total value added by industry for the year 1977 by means of the following procedure: (1) determine value added per employee for each given industry on the basis of national data, adjusted for significant variations;[1] (2) estimate potential employment in each of the 71 firms discharging more than 50,000 gallons per day by assuming that past employment growth trends (1965-1970) will continue in the future; (3) estimate total value added for 1973 (the base year for the Cortell industry survey) by multiplying the actual number of employees by the value-added figure per employee, allowing for productivity increases that are assumed to continue at the rate 1967-71; (4) apply the E x O factor reported in the Cortell study (interpolated for 1977) to the 1973 value added figures. Total shipments were estimated in a similar manner. The results of these estimates are shown in Table 5.5.

The next step consists in assessing the impact of the cost of wastewater treatment on industry prices, assuming no absorption in the form of lower profit rates. Table 5.6 shows the incremental value-added figures for the major dischargers in each industry; these figures are identical to the estimated annual cost to industry shown above. The two sets of figures, for the average water-oriented alternative and for the land application concept, have then been multiplied by the industry-specific markup factor, which have been taken from the EPA publication, The <u>Economics of Clean Water</u>. The resulting figures describe the absolute

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[1] <u>Business Statistics, 1973</u>. Biennial Supplement to the Survey of Current Business, U. S. Department of Commerce.

Table 5.5 PROJECTED ACTIVITY LEVELS FOR FIRMS DISCHARGING MORE THAN 50 KGD, 1977

SIC	Industry	Employment[a]	Total Value Added[b] (in $ Million)	Total Shipments[b] (in $ Million)
20	Food	11,800	350.6	1,045.3
22	Textiles	2,700	39.7	94.9
26	Paper	680	14.3	31.4
28-30	Chemicals	7,800	378.0	661.4
33-35,37	Metals	14,900	297.4	793.1
--	Other	16,200	310.4	618.3
	TOTAL	54,100	1,390.4	3,244.4

[a]Projected at 1965-70 growth rate.

[b]Projected by E x O factor method (see Cortell study)

Table 5.6 ESTIMATED PRICE AND EMPLOYMENT EFFECTS, 1977
(for Major Dischargers)

SIC	Industry	Incremental Value Added[a]	Mark-up Factor	Price Effect[a]	Price Effect in Per Cent	Maximum Number of "Jobs Lost"[b]
20	Food	3.3	.191	3.9	.4	24
22	Textiles	.8	.172	.9	1.0	14
26	Paper	2.2	.238	2.7	8.6	29
28-30	Chemicals	3.7	.396	5.2	.8	31
33-35,37	Metals	.7	.213	.9	.1	8
--	Other	2.9	.232	3.6	.6	49
	TOTAL	13.6	.265	17.2	.5	155

[a] In Million dollars.

[b] Assumed price elasticity of demand/output of -.5.

increase in cost to the consumer of each industry's products under the preliminary assumption that no decline in output would occur. Dividing this price impact measure by the projected value of shipments in the absence of any expenditures on wastewater treatment yields the percentage price increase attributable to the added cost to industry.

In order to estimate the associated employment impact, two additional sets of parameters would have to be known for the firms in the major discharger group: price elasticities of demand, and employment elasticities with respect to changes in output. Neither of these parameters is known. A reasonable estimate of the resulting employment elasticity with respect to changes in price (the product of these two parameters) is -.5, which implies that employment will decline by 5 per cent, once the price increases by 10 per cent. This measure has been used to obtain estimates of the number of "jobs lost" because of the additional cost of wastewater treatment to industry.

6.0 RECREATION

6.1 Major Findings and Conclusions

1. **Impacts on recreational opportunity associated with the five proposed engineering concepts will be largely the result of (a) changes in water quality and (b) acquisition of land for waste treatment and disposal sites.**

2. **Certain positive water-oriented recreation impacts will result from implementation of any one of the five concepts, either because of common elements contained in them or separate actions independently planned. These will occur in Boston Harbor, the North and South coastal areas, and in the Assabet and Concord River basins.**

3. **Between the two centralized water-oriented concepts (1,3), on balance concept 1 should be preferred on recreational grounds because of positive water quality impacts in the Upper Charles basin.**

4. **Between concept 4 and the water-oriented portion of concept 5, the latter configuration should be preferred on recreation grounds because of its avoidance of negative water quality impacts in the Sudbury River basin.**

5. **The basic recreational trade-off between the two water-oriented decentralized concepts (2,4) involves differential impacts in the Mystic and Neponset River basins. The strongly positive impact of concept 4 on water quality in the Aberjona River would, on balance, appear to make concept 4 preferable from the standpoint of recreational opportunity (subject to item 4 above).**

6. **Proposed treatment plant sites at Medford (concepts 4,5), North Canton (concept 2) and Sudbury (all five concepts) conflict directly with existing recreational open space uses.**

7. Taking of land for land application sites in southeastern Massachusetts under concept 5 could have a major negative impact on recreation opportunity, the major unknown being the effect of spray irrigation in Myles Standish and Freetown-Fall River State Forests on public attitudes toward use of these recreational facilities.

6.2 Analysis

The approach taken to the analysis of recreational impacts associated with the five engineering concepts is based on a few straightforward, simplfying assumptions:

First, that recreational opportunity in terms of water-based and water-related activities is enhanced or reduced in a given area depending on changes in present water quality. Where water quality is improved, the possibilities for swimming, fishing, picknicking, camping, hiking, etc. are made more feasible or attractive. Conversely, where water quality is reduced so also are the opportunities for recreational use.

Second, while there is clearly some important relationship between water quality and the actual demand of people for various water-based and water-related facilities, neither the present crude state-of-the-art of recreation forecasting nor the fairly general nature of the proposed engineering concepts lends itself to meaningful quantitative projections of changes in recreational demand. Therefore, this study will not put forward specific projections of future recreation demand in the Eastern Massachusetts Metropolitan Area resulting the implementation of one or another of the five concepts. Instead it will simply (a) identify those elements of each concept which could affect the potential for recreational use in specific basins, (b) characterize them in qualitative terms as beneficial, adverse or neutral, and (c) highlight the relevant trade-offs which may exist among the concepts in terms of their overall impact on recreational opportunity.

Third, that land-based recreational opportunity (including recreational open space) can be affected in particular locations due to land-taking for treatment plants and disposal sites. The nature and extent of the impact in each case will depend on the type of land involved, total acreage, its current

or planned uses, adjacent uses, and the local availability of suitable replacement land. As with water-related recreation, the approach is qualitative rather than quantitative and the objective is to point up conflicts and possible trade-offs among the concepts or impacts to EMMA decision-makers.

6.2.1 Water Quality-Related Impacts

This portion of the analysis is obviously heavily dependent on the best judgements contained in the Environmental and Hygenic components of the EMMA study as to the probable effects of the five engineering concepts on water quality in the various sub-areas and basins. Should these judgements be changed as new or better information becomes available over time, then clearly the analysis of resulting water recreation impacts will likewise have to be reviewed and revised as called for.

Table 6.1 below summarizes the available information from the Environmental and Hygenic impact studies on the likely overall impact of the five alternative concepts on recreational opportunity in the 10 basins. The impacts are shown as positive, negative, or no effect, according to the expected changes in water quality. Where, for instance, it was judged that the positive impact of a particular satellite plant on a basin's flow stabilization recharge would be more than offset by localized impacts such as toxicity and eutrophication, then the overall effect on water quality was assumed to be negative. The assumption is thus made that the effect on water-based and water-related recreational opportunity will also be negative. This is an interesting example in that it points up the methodological problems of assigning one impact characterization where there indeed may exist tradeoffs between individual water activities. Increased flows in a river basin should serve to make recreational boating more popular, regardless of overall effect on water quality; hence increased potential for boating should be deemed a positive recreation impact. In this case however, it was assumed that on balance people would not find boating as attractive an option in areas where water quality is declining, because of aesthetic (algal bloom) or public health (virus) reasons.

The first thing to note in Table 6.1 is that for the first five basins the choice among concepts need not be concerned with differential recreational impacts, for there are no differences and the impacts are all positive. In the case of Boston Harbor it is actually the planned cessation of ocean dumping

Table 6.1

Impacts of Alternative Concepts on Recreational Opportunity

	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
Boston Harbor	+	+	+	+	+
North Coastal	+	+	+	+	+
South Coastal	+	+	+	+	+
Assabet River	+	+	+	+	+
Concord River	+	+	+	+	+
Upper Charles	+	+	-	+	+
Lower Charles	no effect	-	no effect	-	-
Mystic River	no effect	no effect	no effect	+	+
Neponset River	no effect	+	no effect	-	-
Sudbury River	no effect	-	no effect	-	no effect

of sludges, technically not a component of any of the concepts but rather an action that will be taken independently, that largely accounts for the positive impacts. The shift from primary to secondary treatment at Deer and Nut Islands, common to all five concepts, will apparently have very little direct effect on water quality. The actual recreational impact in the Harbor will clearly be a limited one given the continued importance of the major sources of pollution not addressed by the engineering alternatives (combined sewer overflows, and spillage, wastes from industry and ships). At best the Harbor beaches would experience some slight lessening of the public health danger but this is impossible to translate into increased usage of the facilities.

The uniformly positive impacts shown for the North and South Coastal areas and the Assabet and Concord rivers stem from new treatment plants peripheral to the MSD and common to all five concepts. Beaches at Hull and Marshfield in the south and Rockport, Gloucester, Beverly, Salem, Marblehead, Lynn, Nahant and Swampscott in the north should all enjoy a substantial improvement in water quality resulting from the discontinuance of raw sewage discharges to the ocean and the shift to secondary treatment. Hence swimming and other marine sports should benefit. Advanced treatment plants in the western part of Marlborough and at Concord will lead to improved hygienic conditions in recreational areas on the Assabet and Concord rivers, respectively.

Differential recreational impacts relevant to a choice among engineering concepts only begin to appear when one comes to the upper and lower Charles basin, and the Mystic, Neponset and Sudbury rivers. Regarding these basins, Table 6.1 shows that, as between the two centralized concepts, i.e., concepts 1 and 3, a decision-maker concerned with recreation can be indifferent except with respect to the Upper Charles. Here there is a clear difference, because under limited centralization there would be advanced treatment plants at Medway, Medfield and Milford which would presumably exert a positive influence on water quality in those stretches of the river. Under maximum centralization of treatment at Deer and Nut Island these plants would not exist. Instead, there would be a substantial reduction in river flow and a negative impact on water quality and sanitary conditions as water was diverted out of the Upper Charles watershed to Nut Island. Even here it is hard to argue for a substantial impact

on recreational opportunity because of the fact that for much of this part of the river Class C rather than Class B water quality is the proposed goal. Still, recreational boating would clearly suffer under concept 3. The upshot of all this is that, on recreation grounds, a decision-maker should be largely indifferent between the two centralized options, with limited centralization perhaps being the more preferable because of the better result in the Upper Charles.

A second important difference between concepts which emerges from an analysis of Table 6.1 involves concepts 4 and 5. It is clear that, as far as water-related recreational impacts are concerned, the only identifiable difference is in their effort on the Sudbury River. Because of the large influence which the flows from the Framingham treatment plant would exert on the river, concept 4 would accentuate eutrophication problems and likely have a negative impact on sanitary conditions. Concept 5 on the other hand does not include a plant at Framingham, instead piping those wastes to a secondary treatment facility at Dedham. This difference in potential recreation impacts, by itself, is surely not enough of a basis for preferring land application over decentralized advanced plants. Even within the category of recreation, the impacts of the land application sites themselves on recreational opportunities in the 11 southeastern Massachusetts communities where they are located would have to be evaluated (see section 6.2.2). For many other reasons besides recreation land application might not be desirable or acceptable. However, the negative impact caused by the Framingham plant ought to be considered, and perhaps concept 4 altered in some way to modify or eliminate it.

The trade-offs between the two decentralized water-oriented options, concepts 2 and 4, focus on the Mystic and Neponset River basins. Concept 2 would have no apparent effect on recreational opportunity on the Mystic while concept 4, with an advanced plant at Woburn, would have a substantial effect on water quality and river flow in the Aberjona, which flows into the Mystic. As the bathing areas on the Mystic Lakes are also affected by pollution from the Aberjona, concept 4 would appear to be clearly preferable from the point of view of both swimming and boating opportunities. On the Neponset River the situation is reversed. Where concept 2 proposes two separate advanced treatment plants

at Canton, leading to an improvement in water quality due to substantial flow augmentation, concept 4 combines these two into one larger plant whose localized impacts would tend, over all, to offset the flow augmentation benefit. From the Environmental and Hygienic studies it would appear that the positive impact on the Aberjona would be stronger than any negative impact at Canton and, since the Mystic River situation involves clear-cut recreational gains, an EMMA decision-maker looking at the problem from a strictly recreation standpoint should probably prefer concept 4 to concept 2.

Finally, if one lines up concept 1 (limited centralization) and concept 4 (maximum decentralization) the choice on recreational opportunity grounds would be essentially that between having no effect and mostly negative effects. Concept 1 has no impact on water quality in any of the four basins across which the two concepts differ. On the other hand concept 4 has negative impacts in three of the four, the only positive impact being that of the Woburn plant on the Aberjona River. This is hardly much of a basis for choice, but certainly the conservative approach to both water quality and recreational opportunity would be to prefer avoiding negative impacts, and hence favoring concept 1.

6.2.2 Treatment Plant Site Impacts

The more general land use impacts of the various sites proposed for waste treatment plants were discussed previously, in section 2.2. The specific purpose here is to focus cn those sites where it appears that the proposed new plant (or plant expansion) will create conflicts with existing planned or potential recreational uses.

Table 6.2 below summarizes the potential conflicts as they relate to the five proposed engineering concepts. As did section 2.2, this material draws mainly on the individual site assessments done by the Visual-Cultural and Design contractor. It is clear from the chart that the potential recreation conflicts are fairly evenly divided between (a) those that vary among individual concepts, and hence involve differential impacts and (b) those that are common to all five of the concepts. Where the former can provide possible input to decision-makers looking to choose among concepts, the latter would result no matter which concept is chosen. However, in either case concepts can be revised where recreation (and other) impacts make a particular site undesirable as a plant location.

Table 6.2

Potential Conflicts with Recreation Uses: Treatment Plant Sites

	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
Medford				X	X
North Canton		X			
South Canton		X		X	X
Canton					
Medway	X	X		X	X
Medfield	X	X		X	X
Sudbury	X	X	X	X	X
Marlborough West	X	X	X	X	X
Gloucester	X	X	X	X	X
Hudson	X	X	X	X	X

The Medford AWT plant called for in concepts 4 and 5 involves a site presently zoned as an MDC Recreation Area. Also, directly across a parkway from it is a designated historic site. The North Canton site proposed as a part of concept 2 is located within the Fowl Meadow Reservation, and in sight of the Blue Hills reservation. MAPC's Open Space Plan shows it as a Natural Environment Area, and existing public uses include fishing and hiking. The South Canton plant in concept 2, as well as the combined Canton facility under concepts 4 and 5, involve areas proposed for retention by MAPC as natural environment areas, presumably as extensions of the Fowl Meadow Reservation. The town zoning in these two cases is for industrial use. Plans for the Medway treatment plant (concepts 1, 2, 4 and 5) clearly conflict with existing residential and recreational uses around a nearby pond. At Medfield, the proposed expansion of the existing plant directly affects an area with recreational open space potential along the site's edge. The area affected has been recommended by MAPC as a Natural Environment Area. Like Medway, this site is a part of concepts 1, 2, 4 and 5.

With one exception, the potential site conflicts which are common across all five of the concepts are relatively minor. Sudbury, the exception, involves a site on a peninsula which juts out into an existing national and state wildlife refuge area. The Marborough West site is on the shore of the Millham Reservoir; the reservoir itself and the Marshland along the river are significant open space areas and a plant expansion here would have a general effect of reducing potential public uses for recreation. At Gloucester, the plant site would be basically incompatible with preservation of the open marsh areas and potential recreation-oriented development in the immediate area.

Of all the conflicts cited, the major ones would appear to be the Medford plant in the decentralized approaches (4, 5), the North Canton plant in the less decentralized approach (2), and the Sudbury plant which spans all five concepts. Further on-site analysis will be required to determine the possible magnitude of these conflicts with recreational objectives and values.

6.3.3 Land Application Site Impacts

The general land use aspects of the disposal sites proposed in concept 5 were discussed previously (See section 3.3). The main conclusion

reached was that there are no major conflicts with existing or planned uses in the 11 southeastern Massachusetts towns involved. In all these towns vacant land is relatively abundant and not expected to come under development pressure in the foreseeable future. Removing even sizable parcels for land disposal will not, on the whole, seriously reduce the amount of land still available either for development or for open space and recreation. Clearly, the issues over which land disposal is debated will not involve reduction of recreation opportunity, but rather local self-interest and the general relationship of the towns to the Boston area.

The one recreation issue which probably should receive special attention is the location of proposed spray irrigation sites in two state forests. 5037 acres in Myles Standish State Forest, located in Plymouth and Carver, and another 1616 acres in the Freetown--Fall River State Forest will be used for spray irrigation sites. Almost all of the site areas, with the exception of the required buffer zones, will remain available for public recreational use. What is not known is the likely impact, if any, of the spraying on public attitudes toward use of the forests involved. For a number of reasons real or imagined some people simply may not want to tramp around forests which have been sprayed with treated effluent.

Currently Myles Standish State Forest is one of the most heavily used recreation areas in Massachusetts. Therefore, if the impact of spray irrigation on user attitudes were to be negative, the recreation impact of this aspect of concept 5 could be significant. Table 6.3 below shows the level of activity among recreational use categories at Myles Standish State Forest during 1974.

No activity statistics are kept for the Freetown-Fall River State Forest. Although less heavily used than Myles Standish, it does provide current opportunities for hiking, horseback riding, picknicking, and snowmobiling.

TABLE 6.3

RECREATIONAL USE OF MYLES STANDISH STATE FOREST, 1974

ACTIVITY	NO. OF PARTICIPANTS
Camping	160,189
Picknicking	69,075
Hunting	12,115
Tour Driving*	60,821
Horseback Riding	565
Bicycling	2,500
Motorcycling	7,504
Snow Sports	1,275
Activity Totals	314,044

*Includes participation in "Cut-a-Cord" program

Source: Russell Weeks,
Massachusetts Department
of Natural Resources

7.0 COMMERCIAL ACTIVITY

7.1 Major Findings and Conclusions

1. The major commercial activities which potentially will be affected by the proposed engineering alternatives are shellfishing and recreation-related supply and support businesses.

2. No data are available to support detailed analysis of the impact of uncertain water quality changes on the demand for recreation-related commercial services. The only reasonable conclusion would be that such business will gain from improvements in EMMA area water quality, in some general but unspecified manner.

3. The most serious pollution of coastal waters (not including Boston Inner Harbor) comes from towns which currently discharge raw sewage directly into the ocean, such as Gloucester, Essex and Hull. Changeover to secondary treatment in these towns will result in a substantial decrease in concentrations of hazardous substances and thus to a decreased health hazard to shellfish areas.

4. Proposed improvements in collection systems in those faster-growing towns adjacent to North and South Shore shellfishing areas should reinforce the anticipated improvements in coastal water quality and help prevent future contamination.

5. The economic value to commercial fisheries of pollution reduction cannot be estimated precisely due to lack of current data. Anticipated water quality changes may or may not lead to lifting of existing public health restrictions on harvesting. Furthermore, the extent to which the potential benefit may be realizable will depend on market factors such as possible existing over-supply on the one hand and rising prices of competitive food products on the other.

7.2 Effects of Pollution on Commercial Fisheries

Enormous areas of shellfish beds in the study area have been closed to legal harvest over the years because of severe pollution of coastal waters. Although the income thus lost to commercial fisheries is impossible to calculate precisely because of the changing acreages involved and unknown market factors, the figure would be significantly large. Implementation of any of the five proposed wastewater management concepts will generally reduce pollution hazards to shellfish; however, there is no guarantee that existing restrictions on shellfish harvesting will be removed. The results, as far as they can presently be determined, of implementing each concept are summarized in Section 6.3.

The surveying and classification of shellfish areas according to their suitability for harvesting is carried out by the Massachusetts Department of Public Health, which applies a system of four categories to shellfish areas: "approved", "seasonal", "restricted" and "prohibited". The principal basis for classification is the total coliform concentration in the water overlying the shellfish beds.

In Massachusetts, if an area is designated "restricted", only commercial diggers are permitted to harvest there, and the shellfish must be sent to a depuration plant in Newburyport to be purified before being marketed. The cost of depuration is shared by the commercial digger and the cities and towns from which the shellfish are obtained. The "seasonal" classification is applied to areas that are generally restricted but where harvesting must be prohibited during certain seasons, such as recreation areas subject to seasonal pollution from summer houses and boats.

A summary of existing conditions with respect to shellfish harvesting in the study sub-areas follows below.

Boston Harbor:

Water quality in Boston Harbor is so degraded that, as of December 1973, none of the 4806 acres of shellfish beds was classified as "approved" for harvesting: 2756 acres were closed, and 2050 acres were classified as restricted. A map of the Harbor shellfishing areas showing their classification is given on the following page. Many sources

of pollution contribute to the water quality problem in the Harbor. The major ones are: (1) municipal sewage effluent and sludges from the MDC treatment plants on Deer and Nut Islands, (2) combined sewer overflows, (3) industrial discharges, (4) stormwater runoff, (5) oil spillage, (6) polluted tributary streams, (7) refuse and debris, and (8) waste from ships and pleasure boats.

Mystic River Estuary:

Shellfish harvesting in the Mystic River estuary has been prohibited for many years. Large concentrations of oil are a major pollution problem in this area.

Neponset River Estuary:

Shellfish harvesting is prohibited in the estuary. Coliform counts sometime reach 100,000/100 ml.

Charles River Estuary:

Shellfish harvesting has been prohibited here for many years because of extremely high coliform counts due to numerous sources of upstream pollution.

South Coastal Area - North River Estuary:

Large areas of shellfishing beds are closed here, due to a variety of pollution problems. Along the coast of Hull, harvesting is either prohibited or restricted because of raw sewage discharges in the area. Shellfish harvesting is prohibited in Cohasset and Scituate Harbors because of pollution hazards from watercraft and from sewage treatment plant discharges. There are additional shellfish beds closed to harvest in North Scituate, and in Marshfield along the Green Harbor.

North Coastal Area - Ipswich River

Many shellfishing areas in this region, totaling some 2300 acres, are closed because of pollution from raw sewage discharges. Approximately 300 other acres are restricted. In harbors, watercraft wastes, too, contribute to the problem. All shellfish beds from the southernmost part of Lynn north through Beverly are closed, except for 112 acres in the Pine River. From Beverly Harbor north to Ipswich, shellfishing

areas are generally open except for harbors, parts of the Annisquam River in Gloucester, and the tidal portions of the Essex and Ipswich Rivers.

7.3 Impacts of Alternative Concepts on Shellfish Areas

The "Interim Report on Hygienic Impacts"[1] contained assessments of the expected impacts of various plan elements in each of the alternative concept plans upon shellfish areas and the contamination of fish. These expected impacts are summarized below. All citations in this section are taken from the Interim Report.

Boston Harbor

All five concept plans involve change from primary to secondary treatment and the incineration of sludge. The change in level of treatment is expected to result in slight decreases in overall concentrations of bacterial and hazardous substances, such as metals, within Boston Harbor, resulting in slightly decreased hazard to shellfish areas. Boston Harbor, and particularly the Inner Harbor, would continue to be polluted from other sources, however. On the other hand, sludge incineration could have a significant impact on improvement of shellfish areas, especially around some of the Harbor Islands.

The principal differences among the impacts on shellfish of the concept plans in Boston Harbor are that #1 and #3 envisage fewer treatment plants and a larger service area than #2, 4 and 5, and "smaller treatment plants and less intensive collection systems (involved in the latter plans) cause less pollution than larger systems when they are not functioning properly". A somewhat smaller hazard to shellfish areas from malfunctioning would therefore be expected under plans #2, 4 and 5.

South Coastal Area - North River

Plan elements are the same for all five Concept Plans in this area.

The change from secondary treatment to advanced treatment at Rockland would result in a "slight decrease in concentrations of hazardous

[1] "Interim Report, Hygienic Impacts", Eastern Massachusetts Metropolitan Area Wastewater Management Study, U.S. Army Corps of Engineers, 1974.

substances due to improved treatment", with a resultant "decreased hazard of contamination of fish" in the North River.

The greatest impact would come, however, as a result of the change from no treatment to secondary treatment in Hull. In this area there would be a "great decrease in concentrations of hazardous substances, especially bacterial, as the present discharge receives no treatment, and there are no controls on the system". As a result, there would be a decreased hazard to Hull beach and shellfish areas".

The change from primary to secondary treatment in Marshfield would also result in a decrease in bacterial concentrations and a slight decrease in other hazardous substances, resulting in some decreased hazard to Marshfield shellfish areas.

North Coastal Area - Ipswich River

Plan elements are the same for all five Concept Plans in this area.

Advanced treatment in Middleton and Hamilton would result in a "slight increase in concentrations of hazardous substances (in the Ipswich River) by addition of such a large quantity of effluent to the river, as proposed treatment does not remove all such substances" (unless stricter control over metals were exercised at the source, i.e., at the point of discharge into the system). The change from primary to secondary treatment in Ipswich would result in a "slight" decrease in hazardous substances, with some decreased hazard to shellfish areas.

The major impact in this area, however, would come about as the result of the extension of collection systems and the change from no treatment to secondary treatment for coastal towns. In these areas there would be a "great decrease in concentrations of hazardous substances, especially bacteria, as wastewater is currently receiving no treatment, and there are no controls on the system". This in turn would result in decreased hazard to shellfish areas.

Plymouth, Bourne, Sandwich, Cape Cod

In concept 5, land application sites would be developed in Plymouth, Bourne, Sandwich and other Cape towns. According to the

engineers, Whitman & Howard, the best available forecasts indicate that these sites are at a sufficient distance from the waters of Massachusetts Bay and the Cape Cod Canal to rule out any contamination of coastal waters from this source; furthermore, rises in the ground water table associated with land application will not significantly affect the ecology of coastal wetlands with possible changes in salinity.

8.0 AGRICULTURE AND FORESTRY

8.1 Major Findings and Conclusions

1. Concept 5 is the only one of the proposed engineering options which could lead to appreciable impacts on agriculture.

2. The combined impact of the nitrogen "subsidy" involved in spray irrigation and the resulting increase in the productivity of the affected land for forage crops could have a market value of approximately $1.6 million to private farmers.

3. A secondary impact of spray irrigation, of as yet unknown dimensions, could be to adversely affect cranberry growing areas near proposed application sites.

4. It is not possible to place an economic value on the potential impact of spray irrigation of secondarily treated effluent or forested lands in southeastern Massachusetts because of the inconclusive nature of the scientific evidence available.

8.2 Agriculture

This section will discuss possible impacts of the proposed engineering concepts on the agricultural economy of both the EMMA Study Area itself (Essex, Suffolk, Middlesex and Norfolk counties, for the most part) and that portion of southeastern Massachusetts outside the study boundaries but directly effected by land application under concept 5 (Plymouth, Barnstable counties).

Farm population as well as the total number of farms in these areas is small and declining over time. Table 8.1 below provides a county breakdown of (a) farm population relative to total population (b) number of farms, and (c) trends regarding both farm population and number of farms.

TABLE 8.1

FARM POPULATION AND

NUMBER OF FARMS, 1970

COUNTY	FARM POPULATION	TOTAL POPULATION	% FARM POPULATION	% CHANGE 1960-70	NO. OF FARMS	% CHANGE 1960-70
Essex	1031	673,887	.002	-45.8	407	-35.8
Suffolk	-	735,190	-	-	10	-61.5
Middlesex	2180	1,397,268	.002	-45.0	617	-35.5
Norfolk	738	605,051	.001	-76.6	233	-36.5
Plymouth	1920	333,314	.006	-38.4	921	-19.4
Barnstable	227	96,656	.002	-60.2	116	-47.3

Source: City and County Data Book, 1972 pp 232-33

Farm land accounts for only a small proportion of total land in those counties likely to be impacted by the engineering concepts. Furthermore, the individual farms are small, typically under 100 acres.

TABLE 8.2

FARM LAND AND FARM SIZE, 1970

COUNTY	TOTAL FARM ACREAGE	PERCENT OF ALL LAND	AVERAGE FAMILY SIZE (acres)
Essex	46,000	12.4	96
Suffolk	-	.2	7
Middlesex	49,000	9.4	80
Norfolk	18,000	7.0	76
Plymouth	79,000	18.9	110
Barnstable	5,000	2.1	46

Source: City and County Data Book, 1972 pp 232-33

The farms involved are predominantly truck and dairy with some poultry and livestock. The scale of farm operations tends to be small and the value of farm output correspondingly low.

TABLE 8.3

FARM OPERATIONS, 1970

COUNTY	NO. OF FARMS	FARMS WITH SALES $2,500	AVERAGE VALUE OF FARM PRODUCTS WHERE SALES ≥ $2,500	% FARMS WHERE SALES ≥ $40,000
Essex	407	245	$26,895	20.8
Suffolk	10	10	60,545	30.0
Middlesex	617	447	47,328	27.7
Norfolk	233	145	29,294	21.4
Plymouth	721	459	34,343	18.3
Barnstable	116	62	22,683	16.1

Source: City and County Data Book, 1972
pp 232-33

No farm land will be directly affected by the location of proposed treatment plants. Neither do the proposed intercepter corridors appear to open up agricultural land to potential development: the one possible exception being in the Hopkinton area where, regardless of which concept is chosen, some small, locally-oriented farms may be taken out of production which otherwise, in the absence of sewerage, might have remained undeveloped. Concept 5, involving land application of secondarily treated effluent at four proposed sites in Plymouth and Barnstable counties, is the only one of the proposed engineering situations which could lead to appreciable impacts on agriculture in eastern Massachusetts.

A potential impact of implementing the spray irrigation components of concept 5 would be to increase the commercial production of forage crops and thus affect gross farm income. The criteria used by the engineering

contractor for selecting sites suitable for spray irrigation--well drained, good depth to bedrock, adequate loam, not too stony--are also those which identify land well-suited to crop production.[1] The spray irrigation sites chosen in the Freetown-Fall River and Carver-Wareham-Plymouth areas contain 11,800 acres of privately-held land where conceivably crops suc h as meadow grass and silage corn could be profitably, and legally, grown. Production of food for direct human consumption, such as light truck farming, would probably not be permitted by the state because of possible negative public health impacts.

Spray irrigation of these sites according to the general regimen proposed under concept 5 would provide the equivalent in soil nutrients of 250 pounds/acre application of commercial nitrogen fertilizer.[2] At current fertilizer prices this would represent a $70/acre nitrogen "subsidy" to the affected land, or a maximum potential benefit of $826,000.

Application of this amount of nitrogen leads to a direct increase in the productive capacity of the land.[3] Farmers could expect a fairly consistent increase of one ton of meadow grass per acre over what the land would yield unsprayed. The current market price of meadow grass in Massachusetts is approximately $70/ton so the initial nitrogen subsidy could lead to a maximum additional $826,000 in gross farm income. Alternatively, the same nitrogen application increases the potential yield from silage corn, $20/ton, the maximum potential increase in gross farm income would amount to $708,000. So overall, the spray irrigation option could lead to increases in gross farm income of a range of from $1,534,000 to $1,652,000.

A potential secondary impact of land application under concept 5 involves cranberry bogs located in the vicinity of proposed spray irrigation sites. Spray irrigation may result in a rise in the water table in cranberry growing areas, and the possible impact of the nutrients contained in the deposited effluent on the operation of the bogs should be carefully analyzed before any commitment is made to land application. Towns where the proposed sites may create problems for cranberry growers include Carver, Wareham, Bourne and Freetown.

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[1] Conversation with Steve Dean, soil scientist at Whitman and Howard, Inc.

[2] Conversation with M.B. Satterwhite, soil scientist with the New England Division, U.S. Army Corps of Engineers.

[3] Conversation with Dr. Martin Weeks, State Extension Agent, University of Massachusetts, Amherst.

8.3 Forestry

There is no comparable basis for making quantitative estimates of the potential economic benefits which might result from spray irrigation of secondarily-treated effluent on forested land.

Experiments conducted at Pennsylvania State Universiry have shown that, for the application regimen envisioned under Concept 5 (2 inches per week), diameter and height growth of certain tree species is stimulated.[1] Those species favorably impacted were white spruce, mixed oak, white pine, Norway spruce, European larch and Japanese larch, other white spruce showing an average annual height growth increase of from 60 to 200%. But these species are not present for the most part in the forested areas under consideration for spray irrigation in southeastern Massachusetts. Those forests are predominantly scrub oak and pitch pine, with some red pine. The same Pennsylvania State experiments documented an unfavorable impact of spray irrigation on the diameter and height growth rate of red pine.

Also the soil conditions prevalent in the Massachusetts forests being considered are quite different from those in Pennsylvania, and thus the absence of unfavorable groundwater impacts in the Pennsylvania State research may not hold for Massachusetts. The soil here is sandy, droughty, acid, thin in humus. It does not hold nitrogen well and land application on the scale envisioned could conceivably lead to a nuitrent overload in the ground water. One result could be a public health problem regarding local water supplies. Another result could be to stimulate the growth of competitive water plants such as bullrushes and reeds in nearby cranberry bogs. Research is currently underway at Brookhaven National Laroratory on Long Island which could be more directly relevant to the land application situation in Massachusetts: there the same tree species and soil types are present and are being investigated.[2]

Even if the appropriate tree species were present in southeastern Massachusetts, there is still inconclusive evidence on the possible quality-quantity trade-off which might exist regarding increased forest productivity. Accelerated growth of trees is good for forest production, but what is still

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[1] William Sopper, "Effects of Trees and Forests in Neutralizing Water" Institute for Research on Land and Water Resources, Reprint Series No. 23.

[2] Professor George Woodwell and John Bullard, Brookhaven National Laboratory

uncertain is the continued maintenance of fiber quality and its resulting marketability. Finally, other ecological changes will likely result from wastewater application. There will probably be a succession from xeric to mesic to hydric ecology due to the changed moisture content of the soil, and it is not clear what the implications of this will be for the economics of forest production.

9.0 MUNICIPAL FINANCE

9.1 Major Findings and Conclusions

9.1.1 Findings

1. The total capital costs of the four water-oriented concepts are roughly comparable, the spread from lowest (Concept 1) to highest (Concept 3) being only $99 million, or 14%.
2. The projected impacts of capital costs on current property tax rates are nominal across all five concepts. The average tax rate increase associated with the highest cost concept is still less than 1%.
3. Annual operations and maintenance costs are essentially the same for the two centralized concepts (1, 3) and the land disposal option (5). The two decentralized concepts (2,4) are both more than twice as expensive for O&M as these first three.
4. The impacts of annual O&M costs will be substantial under all five concepts, and will represent a heavy additional burden for individual communities. For concept 3, which has the lowest annual O&M costs, the average increase in the O&M assessment for the 41 current MSD member communities over that for FY 1973 would be 108%. Under the concept with the highest annual O&M costs, concept 4, this average increase over FY 1973 jumps to 453%.
5. Allocating the full costs of satellite plants to just the communities they directly serve would unfairly burden these communities by ignoring the dollar value of their previous investments in Deer and Nut Islands. Furthermore, this approach would lead to ruinous increases in annual O&M assessments for satellite communities, on the order of 700 to 1200%.

9.1.2 Conclusions

1. From a least-cost standpoint appropriate to municipal finance, concept 1 is the preferred engineering solution. It combines capital and O&M cost savings to the greatest extent attainable under the five concepts proposed.

2. Next most preferred are concepts 3 and 5. They entail capital expenditures $94 million higher than concept 2, but the differential impact on tax rates is nominal while the annual O&M cost savings over concept 2 are substantial. As between concepts 3 and 5, concept 3 is preferred on the basis of a slightly greater O&M cost saving.

3. The two decentralized concepts (2,4) are the most expensive and hence the least preferred. Of these two, concept 2 is preferable to concept 4 on the basis of overall costs.

4. The MDC should be enabled to continue allocating annual capital and O&M costs to its member communities on a region-wide basis rather than at the individual facility level.

9.2 Analysis

For the purposes of this interim report the analysis of municipal finance impacts has been kept limited to those 55 communities within the EMMA study area which would be affected by differences among the five proposed engineering concepts. Financial effects on the remaining cities and towns which would be served by peripheral systems common to all the alternatives will not be ignored, but rather will be dealt with at a later stage, in the final report. For now the objective is to highlight differential impacts across concepts so as to provide decision-makers with some basis for an informed choice.

The analysis concentrates on the direct impacts on local finances of the construction and operation and maintenance costs associated with the five engineering concepts. It also deals with possible differences in impacts based on alternative assumptions about cost allocation. At this point no attempt is made to incorporate estimates of secondary impacts such as the costs of removing land from the local tax base for treatment and disposal sites or

the tax rate benefits of induced residential or industrial development. These issues are specific to particular towns and difficult to handle within the overall comparative approach employed in this section.

9.2.1 Capital Costs

Table 9.1 below summarizes the total capital costs, including those for treatment facilities, pumping stations and interceptors, associated with the five engineering alternatives under consideration. It also indicates that portion of capital costs which fall to local communities, and translates that 10% local share into average annual debt service costs assuming an interest rate of 6.875% over a 20 year term. Costs for peripheral communities are excluded.

Table 9.1

Comparative Capital Costs *

(000)

	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
Deer and Nut Islands	$675	$456	$825	$431	$431
Satellite Systems	51	275	0	367	489
Totals	$726	$731	$825	$798	$920
10% Local Share	$72.6	$73.1	$82.5	$79.8	$92.0
Average Annual Debt Service	$6.7	$6.8	$7.6	$7.4	$8.6

*These costs do not include peripheral systems.

Sources: Metcalf and Eddy, Whitman and Howard.

Among the five engineering concepts the total capital costs do not differ markedly. The most expensive of these, concept 5, exceeds the low-cost concept 1 by only 26%.

Clearly, total capital costs by themselves will not provide a very useful criterion for discriminating among degrees of preference regarding engineering solutions.

Table 9.2 translates the aggregate annual debt service requirements for each of the five concepts into the dollar costs which would be faced by the individual communities affected. The costs were allocated to the cities and towns based on their estimated 1990 populations (see Metcalf & Eddy <u>Planning Study</u>) expressed as a percentage of the total estimated 1990 population to be served by the overall system. While MDC does not currently use this method for allocating capital costs to existing MSD member communities, it has recommended such an approach to the legislature regarding future system expansion, and thus the approach used here is consistent with MDC's own intentions. 1990 estimates of population were used as this data should fall at roughly the midpoint of the life of the work. Inspection of the figures in Table 9.2 indicates that since the aggregate debt service totals for the five concepts were relatively so close to begin with, no one concept imposes a dramatically heavier annual debt service burden on individual communities than do the others. Also, the differences in tax rate increases across concepts would be minimal. The average tax rate increase for the 55 affected communities under each of the five concepts would be less than 1% (using FY 1973 property tax rates and total assessed valuations).

None of the concepts proposed involve overly burdensome capital cost impacts on individual communities, nor do these impacts differ greatly across concepts. Therefore, it becomes doubly important in terms of making choices among concepts to analyze the differential impacts of annual operations and maintenance costs.

9.2.2 <u>Operations and Maintenance Costs</u>

Table 9.3 summarizes the annual operations and maintenance costs associated with the five proposed engineering concepts.

TABLE 9.2

AVERAGE ANNUAL DEBT SERVICE FOR LOCAL SHARE OF CONSTRUCTION COSTS:

	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
ARLINGTON	134,000	136,000	152,000	148,000	152,000
ASHLAND	33,500	34,000	38,000	37,000	38,000
BELMONT	67,000	68,000	76,000	74,000	76,000
BOSTON	1,467,300	1,489,200	1,664,400	1,620,600	1,664,400
BRAINTREE	107,200	108,800	121,600	118,400	121,600
BROOKLINE	160,800	163,400	186,400	177,600	182,400
BURLINGTON	80,400	81,600	91,200	88,800	91,200
CAMBRIDGE	261,300	265,200	296,400	288,600	296,400
CANTON	73,700	74,800	83,600	81,400	83,600
CHELSEA	60,300	61,200	68,400	66,600	68,400
DEDHAM	67,000	68,000	76,000	74,000	76,000
EVERETT	93,800	95,200	106,400	103,600	106,400
FRAMINGHAM	194,300	197,200	220,400	214,600	220,400
HINGHAM	60,300	61,200	68,400	66,600	68,400
LEXINGTON	100,500	102,000	114,000	111,000	114,000
MALDEN	134,000	136,000	152,000	148,000	152,000
MEDFORD	174,200	176,800	197,600	192,400	197,600
MELROSE	93,800	95,200	106,400	103,600	106,400
MILTON	87,100	88,400	98,800	96,200	98,800
NATICK	100,500	102,000	114,000	111,000	114,000
NEEDHAM	100,500	102,000	114,000	111,000	114,000
NEWTON	254,600	258,400	288,800	281,200	288,800
NORWOOD	67,000	68,000	76,000	74,000	76,000
QUINCY	241,200	244,800	273,600	266,400	273,600
RANDOLPH	80,400	81,600	91,200	88,000	93,600
READING	73,700	74,800	83,600	81,400	88,600
REVERE	113,900	115,600	129,200	125,800	129,200
SOMERVILLE	180,900	183,600	205,200	199,800	205,200
STONEHAM	53,600	54,400	60,800	59,200	60,800
STOUGHTON	80,400	81,600	91,200	88,000	93,600
WAKEFIELD	80,400	81,600	91,200	88,000	93,600
WALPOLE	73,700	74,800	83,600	81.400	83,600
WALTHAM	207,700	210,800	235,600	229,400	235,600
WATERTOWN	80,400	81,600	91,200	88,000	91,200
WELLESLEY	80,400	81,600	91,200	88,000	91,200
WESTWOOD	53,600	54,400	60,800	59,200	60,800
WEYMOUTH	154,100	156,400	174,800	170,200	174,800
WILMINGTON	67,000	68,000	76,000	74,000	76,000
WINCHESTER	67,000	68,000	76,000	74,000	76,000
WINTHROP	60,300	61,200	68,400	66,600	68,400
WOBURN	120,600	122,400	136,800	133,200	136,800
BEDFORD	46,900	61,200	53,200	51,800	53,200
HOLBROOK	33,500	34,000	38,000	37,000	38,800
HOPKINTON	26,800	27,200	30,400	29,600	30,400
LINCOLN	26,800	27,200	30,400	29,600	30,400
LYNNFIELD	40,200	40,800	45,600	44,000	45,600
SHARON	46,900	61,200	53,200	51,800	53,200
WESTON	40,200	40,800	45,600	44,000	45,600
SOUTHBOROUGH	26,800	27,200	30,400	29,600	30,400
FRANKLIN	60,300	61,200	68,400	66,600	68,400
HOLLISTON	46,900	61,200	53,200	51,800	53,200
MEDFIELD	40,200	40,800	45,600	44,000	45,600
MEDWAY	26,800	27,200	30,400	29,600	30,400
MILFORD	53,600	54,400	60,800	59,200	60,800
MILLIS	26,800	27,200	30,400	29,600	30,400
WRENTHAM	20,100	20,400	22,800	22,200	22,800
MARLBOROUGH	87,100	88,400	98,800	96,200	98,800
BELLINGHAM	40,200	40,800	45,600	44,000	45,600

Table 9.3

Annual O&M Costs

(000)

	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
Deer and Nut Islands	$17	$15	$17	$14	$14
Satellite Systems	4	24	1	33	7
	$21	$39	$18	$47	$21

Centralization of treatment at Deer and Nut Islands (Concepts 1,3) clearly minimizes annual O&M costs. Of the decentralized approaches, concept 5 has the lowest O&M costs because of its substitution of secondary treatment and land disposal for more expensive tertiary plants Decentralization (concepts 2,4) carries a current O&M cost roughly double that for the Deer and Nut Island options.

Given the total capital costs for the concepts arrayed previously (refer back to Table 9.1), concept 1 combines capital and O&M cost savings to the greatest extent attainable under the proposed engineering alternatives. Concept 2, the limited decentralization option, shows lower capital costs than do concepts 3 or 5, but it should be recalled that this difference ($94 million) becomes nominal when the 10% level share is translated into property tax rate increases at the community level. However, the higher annual O&M cost attached to concept 2 ($39 million to $18 million) has very significant implications for local operating budgets. O&M costs are 100% funded by local government and thus this $21 million difference has to be picked up entirely by the individual communities involved. Thus, economic logic would cause local communities to prefer concepts 3 or 5 over the advanced satellite plants (concepts 2,4) if minimizing the local finance burden were the sole criterion for choice among the concepts. Concept 3 is slightly preferred over concept 2 because of other cost savings. Concept 2 is still preferred over concept 4 on both capital and O&M cost grounds.

Table 9.4 below shows how the annual O&M costs associated with each of the five concepts would be distributed among the affected communities using the current MDC allocation approach and estimated 1990 populations as a percentage of total estimated system population. Actual impact on local finances can perhaps be more accurately portrayed by comparing these estimated 1990 costs to

TABLE 9.4

ANNUAL OPERATIONS AND MAINTENANCE COSTS

	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
ARLINGTON	420,000	780,000	360,000	940,000	420,000
ASHLAND	105,000	195,000	90,000	235,000	105,000
BELMONT	210,000	390,000	180,000	470,000	210,000
BOSTON	4,599,000	8,541,000	3,942,000	10,293,000	4,599,000
BRAINTREE	336,000	624,000	288,000	752,000	336,000
BROOKLINE	504,000	936,000	432,000	1,128,000	504,000
BURLINGTON	252,000	468,000	216,000	564,000	252,000
CAMBRIDGE	819,000	1,521,000	702,000	1,833,000	819,000
CANTON	231,000	429,000	198,000	517,000	231,000
CHELSEA	189,000	351,000	162,000	423,000	189,000
DEDHAM	210,000	390,000	180,000	470,000	210,000
EVERETT	294,000	546,000	252,000	658,000	294,000
FRAMINGHAM	609,000	1,131,000	522,000	1,363,000	609,000
HINGHAM	189,000	351,000	162,000	423,000	189,000
LEXINGTON	315,000	585,000	270,000	705,000	315,000
MALDEN	420,000	780,000	360,000	940,000	420,000
MEDFORD	546,000	1,014,000	468,000	1,222,000	546,000
MELROSE	294,000	546,000	252,000	658,000	294,000
MILTON	273,000	507,000	234,000	611,000	273,000
NATICK	315,000	585,000	270,000	705,000	315,000
NEEDHAM	315,000	585,000	270,000	705,000	315,000
NEWTON	798,000	1,482,000	684,000	1,786,000	798,000
NORWOOD	210,000	390,000	180,000	470,000	210,000
QUINCY	756,000	1,404,000	648,000	1,692,000	756,000
RANDOLPH	252,000	468,000	216,000	564,000	252,000
READING	231,000	429,000	198,000	517,000	231,000
REVERE	357,000	663,000	306,000	799,000	357,000
SOMERVILLE	567,000	1,053,000	486,000	1,269,000	567,000
STONEHAM	168,000	312,000	144,000	376,000	168,000
STOUGHTON	252,000	468,000	216,000	564,000	252,000
WAKEFIELD	252,000	468,000	216,000	564,000	252,000
WALPOLE	231,000	429,000	198,000	517,000	231,000
WALTHAM	651,000	1,209,000	558,000	1,459,000	651,000
WATERTOWN	252,000	468,000	216,000	564,000	252,000
WELLESLEY	252,000	468,000	216,000	564,000	252,000
WESTWOOD	168,000	312,000	144,000	376,000	168,000
WEYMOUTH	483,000	897,000	414,000	1,081,000	483,000
WILINGTON	210,000	390,000	180,000	470,000	210,000
WINCHESTER	189,000	351,000	162,000	473,000	189,000
WINTHROP	210,000	390,000	180,000	470,000	210,000
WOBURN	378,000	702,000	324,000	846,000	378,000
BEDFORD	147,000	273,000	126,000	329,000	147,000
HOLBROOK	105,000	195,000	90,000	235,000	105,000
HOPKINTON	84,000	156,000	72,000	188,000	84,000
LINCOLN	84,000	156,000	72,000	188,000	84,000
LYNNFIELD	126,000	234,000	108,000	282,000	126,000
SHARON	147,000	273,000	126,000	329,000	147,000
WESTON	126,000	234,000	108,000	282,000	126,000
SOUTHBOROUGH	84,000	156,000	72,000	188,000	84,000
FRANKLIN	210,000	390,000	180,000	470,000	210,000
HOLLISTON	147,000	273,000	126,000	329,000	147,000
MEDFIELD	126,000	234,000	108,000	282,000	126,000
MEDWAY	84,000	156,000	72,000	188,000	84,000
MILFORD	168,000	312,000	144,000	376,000	168,000
MILLIS	84,000	156,000	72,000	188,000	84,000
WRENTHAM	63,000	117,000	54,000	141,000	63,000
MARLBOROUGH	273,000	507,000	234,000	611,000	273,000
BELLINGHAM	126,000	234,000	108,000	282,000	126,000

the communities' FY 1973 O&M assessments and computing the percentage increases. This is done in Table 9.5 for the 41 current MSD members, using the concepts with the lowest (3) and the highest (4) annual O&M costs to give a sense of the range over which the increases would be approximately 135%. Concept 4, with its sophisticated advanced treatment facilities would drive the average O&M increase up to about 520%. Under a recent, definitive ruling of the Comptroller General, an individual community cannot in turn place these added O&M costs on the local property tax. Instead the community must seek to recover a fair share of O&M costs from all users of the system, based on factors that affect the costs of treatment. For this reason the added O&M costs represented by the various engineering concepts were not translated into local tax rate increases.

9.2.3 Cost Allocation Issues

Resolution of two issues currently outstanding could directly affect the validity of some or all of the cost allocations to individual communities shown in the previous sections.

The first issue concerns whether or not the MDC can continue to assess local communities for annual O&M costs based on their respective populations. This practice is clearly not consistent with the requirements of PL 92-500 regarding user charges and in all likelihood will have to be changed by action of the Massachusetts legislature. The new basis for determining a community's O&M costs will probably have to be based on wasteload characteristics affecting actual treatment costs. Thus, the O&M cost allocations shown in Table 9.4 will likely change. MDC's expressed desire to also allocate future capital costs to communities according to population does not raise similar problems. The federal law given the MDC (i.e., the State) complete discretion as to how to determine these costs.

The second issue goes to the heart of the regional nature of the MDC system. PL 92-500 is ambiguous as to whether the MDC can continue to allocate both capital and O&M costs to all member communities out of single region-wide pot, or whether instead it must allocate the

TABLE 9.5

Comparative Analysis of Local O&M Cost Increases

		Concept 3 Lowest O&M Cost Option		Concept 4 Highest O&M Cost Option	
	FY 1973 Assess.	Concept 3 Costs	% Increase	Concept 4 Costs	% Increase
ARLINGTON	183	360	97	940	414
ASHLAND	31	90	190	235	658
BELMONT	98	180	84	470	380
BOSTON	2177	3942	81	10293	373
BRAINTREE	126	288	129	752	497
BROOKLINE	185	432	134	1128	510
BURLINGTON	81	216	167	564	596
CAMBRIDGE	301	702	133	1833	509
CANTON	60	198	230	517	762
CHELSEA	98	162	65	423	332
DEDHAM	96	189	88	470	390
EVERETT	144	252	75	658	357
FRAMINGHAM	212	522	146	1363	543
HINGHAM	25	162	548	423	1592
LEXINGTON	117	270	131	705	503
MALDEN	195	360	85	940	382
MEDFORD	217	468	116	1222	463
MELROSE	113	252	123	658	482
MILTON	95	234	146	611	543
NATICK	107	270	152	705	559
NEEDHAM	107	270	152	705	559
NEWTON	310	684	121	1786	476
NORWOOD	108	180	67	470	335
QUINCY	313	648	107	1692	441
RANDOLPH	99	216	118	564	470
READING	79	198	151	517	554
REVERE	149	306	105	799	436
SOMERVILLE	297	486	64	1269	327
STONEHAM	75	144	92	376	401
STOUGHTON	82	216	163	564	588
WAKEFIELD	86	216	151	564	550
WALPOLE	63	198	199	517	721
WALTHAM	201	558	178	1457	625
WATERTOWN	135	216	60	504	317
WELLESLEY	94	216	130	564	500
WESTWOOD	47	144	206	376	700
WEYMOUTH	195	414	112	1081	454
WILMINGTON	60	180	200	470	683
WINCHESTER	80	162	73	423	429
WINTHROP	68	180	62	470	591
WOBURN	121	324	168	846	599

costs of each individual facility to just those communities that facility directly serves. The question is one of equity. EPA's unofficial position has been that the regional entity, in order to allocate the cost of federally assisted treatment facilities region-wide, must be able to demonstrate that the particular facility for which funds are requested is an integral part of an overall plan for eventually extending services to the entire region. The proposed engineering concepts would appear to be able to meet this test, but the issue has yet to be formally resolved between the MDC and EPA. If EPA did require the MDC to allocate capital and O&M costs among communities at the facility rather than the system-level, then the cost figures shown in Tables 9.2 and 9.4 respectively, would have to be recalculated.

Philosophic and legal arguments aside, it can be shown that such a decision by EPA in this case would lead to severe economic consequences for those members of the MDC currently tied to Deer and Nut Island which, under the various decentralized concepts (2,4,5), would be served by the new satellite plants. The differential impact on tax rates of the higher debt service costs would not be too significant, as the debt service differences between the two allocation methods are not large. The real impact would be felt on these towns' annual O&M assessments, because O&M must be completely paid for locally. Table 9.6 shows dramatic evidence of the potential fiscal impact on satellite communities. In it the O&M cost burdens for 22 satellite communities under concept 4 (the highest O&M concept) are calculated using a facility-level allocation approach and then compared to their FY 1973 O&M assessments and the percentage increases computed. As can be seen the increases range from 700 to 1200% in almost all cases. Clearly these kinds of increases cannot be absorbed by the satellite communities, wholly apart from the equity question of whether they should be required to do so.

TABLE 9.6

Impact of Facility-Level Allocation Approach on Local O&M Costs

	FY 1973 O&M Assessment	Concept 4 O&M Costs	% Increase
ASHLAND	30	159	430
FRAMINGHAM	212	2783	1213
NATICK	107	1318	1132
NEEDHAM	107	1264	1081
WELLESLEY	94	1188	1164
CANTON	60	725	1294
NORWOOD	108	1308	1111
STOUGHTON	82	997	1116
WALPOLE	63	769	1121
WESTWOOD	47	258	449
NEWTON	310	2827	812
WALTHAM	201	2061	925
WATERTOWN	135	1198	780
BURLINGTON	81	946	1068
READING	79	961	1116
STONEHAM	75	708	844
WILMINGTON	60	738	1130
WINCHESTER	80	707	784
WOBURN	121	1607	1228
ARLINGTON	183	1678	817
BELMONT	98	826	743
LEXINGTON	117	997	752

10.0 EMPLOYMENT AND INCOME

10.1 Major Findings and Conclusions

1. The proposed engineering concepts can potentially affect income and employment through a variety of channels, including construction jobs, plant O&M employment, industrial jobs, recreation-based commercial employment, agricultural income, and municipal taxes.

2. No clear pattern regarding an overall preference ordering among the five concepts can be detected by examining these individual partial impacts. The decentralized options maximize the direct employment benefits. The centralized options minimize the fiscal impact on local taxes and hence, personal incomes. Other impacts, with the exception of agricultural income, either do not discriminate among options or rest on such shaky data as to be of doubtful utility for making choices.

3. On balance, the impacts on municipal finance would appear to be relatively the strongest as they affect income and thus Concepts 1 and 3 are preferred, followed by Concepts 5, 2 and then 4.

10.2 Analysis

Impact on overall employment and income is determined by the cumulative partial impacts of the proposed engineering concepts on the various aspects of the regional economy discussed in earlier chapters. That is, the concepts can differentially affect construction employment, plant O&M employment, industrial jobs, commercial employment in such areas as recreation and shell-fishing, agricultural income and personal taxes. The task of summing these individual partial impacts within and across concepts is an extremely difficult one, virtually impossible in any strict, quantitative sense. The engineering data for plant O&M jobs is not available, and the estimates for construction employment are necessarily general. Neither the

needed data nor the methodology are available for translating water quality changes into added employment in recreation and commercial fishing. Nor is it possible to discriminate among concepts of roughly similar costs as to potential industrial job losses. Therefore, this section will simply examine and summarize what employment and income-related data are available for each of the relevant impact categories and attempt to come to some general conclusions regarding differential impacts across engineering concepts. Obviously, these conclusions will be limited in their accuracy and usefulness and should not be pressed too far for decision-making purposes.

Construction Employment

Estimates for construction employment are available from Metcalf and Eddy for the four water-oriented concepts. These are displayed in Table 9.1 below, by concept, expressed in terms of construction employee man-months. Only Deer and Nut Islands and sattelite plants are included.

TABLE 10.1

Estimated Construction Employee Man-Months for the Four Water-Oriented Concepts[1]

	Concept 1	Concept 2	Concept 3	Concept 4
Deer & Nut Islands	45,120	30,480	55,200	14,880
Canton	0	0	0	8,775
Canton North	0	2,904	0	0
Canton South	0	7,605	0	0
Dedham	0	6,435	0	5,940
Framingham	0	5,940	0	5,940
Marlborough East	315	0	0	0
Medfield	2,805	2,805	0	2,805
Medford	0	0	0	8,775
Medway	3,036	3,036	0	3,036
Milford	1,404	1,404	0	1,404
Watertown	0	12,375	0	12,375
Woburn	0	0	0	8,775
CONCEPT TOTALS	52,680	72,984	55,200	72,705

[1]Midpoints of employee and time duration ranges were used for all computations. Number of construction employees for Concepts 1, 2, and 3 were assumed to be proportional to plant costs similar to the ratio for Concept 4.

As would be expected, the two decentralized concepts (2,4), which call for the greater number of plants to be built, generate the higher construction employment totals. Maximum expansion at Deer and Nut Islands (3) leads to construction employment slightly higher than for the limited centralization option (1).

Plant O&M Employment

Engineering data on estimated plant O&M jobs are not available as of yet. In lieu of hard data, the reasonable assumption would be that O&M employment is directly related to the number of plants envisioned under a particular concept. Therefore, Concept 4 which calls for 12 new or expanded wastewater treatment facilities would generate the greatest number of permanent O&M jobs, followed by Concepts 2 and 5. Concepts 2 and 5 each involve one less treatment plant, but it is not clear which would generate more permanent jobs because of the possible employment trade-off as between levels of treatment at sattelite plants (2 advanced, 5 secondary) and the added job requirements of land treatment systems (5). Partial centralization (1) involves three more plants than maximum centralization (3) and hence creates more permanent jobs. In all cases, however, the total number of O&M jobs involved will likely not be great, and thus the differential employment impacts hardly significant.

Industrial Employment

As discussed earlier in Chapter 4, the expected job losses among major industrial discharges from implementing any of the proposed engineering concepts are minimal. Given the rough comparability of total capital costs associated with the five concpets, it was not deemed feasible or useful to attempt to discriminate further among them regarding comparative job loss figures. If a preference ordering were required, the only reasonable basis would be to minimize total costs, assuming job loss directly proportional to the total industrial cost burden. In that case, Concept 1 would be the preferred option, followed by Concepts 3, 5, 2 and 4. (Refer back to Chapter 9.)

Commercial Activity

It is simply not possible to estimate the increased income, if any, which would accrue to commercial shell-fishing due to the implementation of any of the five proposed concepts. There is no data available to support a conclusion that water quality increases in coastal areas will lead to an increased shell fish population, or a lifting of current public health bans on harvesting. Furthermore, since whatever water quality changes take place in coastal waters will be common across all five concepts, there is no basis for preferring one concept over another in terms of beneficial economic impact on shell-fishing.

Regarding recreation-based commercial activity, it is again very difficult to distinguish differential impacts across the five proposed engineering concepts. The general assumption made (refer to Chapters 5,6) was that recreational opportunity, and hence related recreational business activity, would benefit directly as water quality increases (or decreases), occurred. Based on the water quality impact data available, the pattern of anticipated water quality changes is not such as to clearly favor one engineering concept over the others. Between the two centralized water-oriented concepts (1,3), concept 1 is preferred because of its avoidance of a negative impact in the Upper Charles. Among the three decentralized concepts, 5 is preferred to 4 because it avoids a negative impact in the Sudbury basin, and on balance, concept 4 is preferred over concept 2 because of a strongly positive impact in the Mystic basin. Trade-offs between centralization and decentralization cannot really be formulated, unless one takes the very conservative position that concept 1 by avoiding any negative impacts is preferable to concepts 5, 4 or 2 which all entail some negative impacts. Clearly, the only beneficial impacts on water-related recreation businesses that would be realized by implementing concept 1 would be those due to trend increases in recreation demand, not to any changes in the supply of recreational opportunities.

Agricultural Income

Concept 5 is the only one of the five proposed options which entails a direct economic impact on agriculture. Spray irrigation effectively confers a subsidy on owners of privately-held agricultural land by enriching the soil with nitrogen and other nutrients which otherwise must be purchased

commercially. Approximately 11,800 acres of privately-held land suitable for agricultural use would be affected by spray-irrigation under concept 5. The proposed irrigation practices would result in an equivalent nitrogen application of 250 lbs./acre, or at current furtilizer prices a subsidy of approximately $70/acre. Over 11,800 acres, this subsidy amounts to $826,000.

Assuming that the affected land could be put into commercial production of meadow grass, the estimated additional yield per acre due to the nitrogen application would be a fairly consistent 1 ton per acre. At a current market price for meadow grass of $70/ton, the maximum gross benefit to farmers would increase by another $826,000. Alternatively, if the land were put into silage corn the estimated additional yield due to the nitrogen would be approximately 3 tons/acre. At a current market price for silage corn of $20/ton, the additional benefit from production would then be $708,000. Therefore, under concept 5 there is a maximum potential economic benefit to farmers of approximately $1,652,000 in gross income. Clearly, from the agricultural viewpoint, concept 5 is the preferred option, with farmers being indifferent as among the other four.

<u>Personal Income</u>

As covered in detail in Chapter 8, the impacts of construction costs on municipal tax rates in the EMMA study area are minimal under any of the five proposed concepts, amounting to an average increase of less than 1%. The major differential impact as it affects personal incomes comes with the differences across concepts regarding annual O&M costs. These costs must be fully recovered from local users. Looking at total annual costs, the preference ordering among the concepts in terms of limiting impact on personal incomes is 1, 3, 5, 2 and then 4.

<u>Impact Summary</u>

Table 9.2 below summarizes the discussion of the various employment and income impacts in terms of their implications for preference among the five proposed engineering concepts. No overall pattern regarding preferences emerges. Direct employment impacts favor the decentralized options, but the differential impacts are small. The impacts on recreation-based commercial activity are aleady two removes away from uncertain changes in water quality, and thus little weight can be attached to these. With

TABLE 10.2

Preference Orderings by Employment and Income Impacts

	Concepts				
	1	2	3	4	5
Construction Employment (Employee Man Months)	5	1	4	2	3
O&M Jobs (No. of WWTP's)	4	3	5	1	2
Industrial Employment	NO DIFFERENCE				
Recreation-based Employment (Changes in Water Quality)	1	4	5	3	2
Commercial Fishing	NO DIFFERENCE				
Agricultural Income	NO DIFFERENCE - 2				
Personal Income	1	4	2	5	3

the exception of agriculture, the only really clear-cut differential impact is on personal income, due to the costs of plant construction and O&M. On a cost basis the two centralized options (concepts 1, 3) are the most attractive, and the differential impacts are sizeable. Therefore, the controlling factor in an overall preference ordering for employment and income impacts should probably be these impacts on personal income through the municipal tax mechanism.

11.0 Appendices

11.1 Population and Land Use Data on Selected Communities

11.2 Maps Showing Undeveloped Land in Proposed Sewered Areas for Selected Communities

APPENDIX 11.1

The following tables show the results of data runs of the Empiric Model, for the period 1970 to 1990, by Metcalf & Eddy.

ASHLAND (003)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970 to 1990 High
POPULATION					
M/E	7779	8882	14889	13906	+ 6007
RPC	7779	8882	16100	18300	+ 7218
HOUSEHOLDS	2072	2449	4233	3952	+ 1784
EMPLOYMENT - TOTAL	2862	4937	11563	10299	+ 6626
- in "wet" or "very wet" mfg.	115	191	214	158	+ 23
- commercial emp.	849	1560	4500	4500	+ 2940
TOTAL ACRES (a+b+c)	8294	8294	8294	8294	0
(a) Total "used" acres	873	1122	2097	2011	+ 975
net res. acres	732	865	1545	1486	+ 680
net comm. acres	104	191	387	387	+ 196
net indust. acres	37	67	166	139	+ 99
(b) Total "committed acres					
ext. indust.	209	209	209	209	0
ext. institut.	170	170	170	170	0
streets/hwys	259	289	419	407	+ 130
restr. open space	968	968	1010	1007	+ 42
(c) Vacant avail. acres	5815	5539	4392	4492	- 1147
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	5539	4392	4492	- 1147
(f) Total Developable (a+e)	n.a.	6661	6489	6503	- 172
(g) Est. sewered of all (f)	n.a.	200	4542	4552	+ 4342
% sewered of total developable acres (g ÷ f)	n.a.	3	70	70	+ 67
% "used" of total developable acres (a ÷ f)	n.a.	17	32	31	+ 15
Res. Density (HH/Acre)	n.a.	3	4	4	+ 1

BELLINGHAM (006)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	6774	13967	16014	15362	+ 2047
RPC	6774	13967	22400	20700	+ 8433
HOUSEHOLDS	1831	3600	4324	4148	+ 724
EMPLOYMENT - TOTAL	1175	1499	3448	2865	+ 1949
- in "wet" or "very wet" mfg.	418	35	62	51	+ 27
TOTAL ACRES (a+b+c)	12070	12070	12070	12070	----
(a) Total "used" acres	1094	1928	2367	2275	+ 439
net res. acres	716	1408	1730	1670	+ 322
net comm. acres	136	297	364	344	+ 67
net indust. acres	242	224	274	262	+ 50
(b) Total "committed acres	2072	2240	2319	2302	+ 79
ext. indust.	262	262	262	262	0
ext. institut.	0	0	0	0	0
streets/hwys	374	542	599	586	+ 57
restr. open space	1436	1436	1458	1454	+ 22
(c) Vacant avail. acres	8905	7902	7383	7493	- 519
(d) Vacant avail. but unsuit. for devel.	n.a.	3645	3645	3645	0
(e) Vacant, avail, suitable	n.a.	4257	3738	3848	- 519
(f) Total Developable (a+e)	n.a.	6185	6105	6123	- 80
(g) Est. sewered of all (f)	0	0	1830	1830	+ 1830
% sewered of total developable acres (g ÷ f)	0	0	30	30	+ 30
% "used" of total developable acres (a ÷ f)	n.a.	31	39	37	+ 8
Res. Density (HH/Acre)	n.a.	3	3	3	0

FRAMINGHAM (031)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	44526	64048	79105	75881	+ 15057
RPC	44526	64048	72100	72800	+ 8052
HOUSEHOLDS	12286	19089	24583	23543	+ 5494
EMPLOYMENT - TOTAL	16946	26886	32861	28001	+ 5975
- in "wet" or "very wet" mfg.	2965	3847	3896	3109	+ 49
TOTAL ACRES (a+b+c)	17453	17453	17453	17453	0
(a) Total "used" acres	3215	7252	8824	8498	+ 1572
net res. acres	1535	5554	6865	6704	+ 1311
net comm. acres	1300	1363	1535	1446	+ 172
net indust. acres	380	334	423	349	+ 89
(b) Total "committed acres					
ext. indust.	419	419	419	419	0
ext. institut.	2	2	2	2	0
streets/hwys	1428	1749	1941	1891	+ 192
restr. open space	1776	1776	1838	1830	+ 62
(c) Vacant avail. acres	10613	6254	4429	4812	- 1825
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	6254	4429	4812	- 1825
(f) Total Developable (a+e)	n.a.	13506	13253	13310	- 253
(g) Est. sewered of all (f)	n.a.	10535	11928	11979	+ 1393
% sewered of total developable acres ($g \div f$)	n.a.	78	90	90	+ 12
% "used" of total developable acres ($a \div f$)	n.a.	54	67	64	+ 13
Res. Density (HH/Acre)	n.a.	3	8	8	+ 5

FRANKLIN (032)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	10530	18067	24732	23519	+ 6665
RPC	10530	18067	31500	28800	+ 13433
HOUSEHOLDS	2849	4340	6444	6117	+ 2104
EMPLOYMENT - TOTAL	2111	2788	5257	4622	+ 2469
- in "wet" or "very wet" mfg.	564	415	498	421	+ 83
TOTAL ACRES (a+b+c)	17280	17280	17280	17280	0
(a) Total "used" acres	1261	1891	3176	3034	+ 1285
net res. acres	1027	1564	2694	2591	+ 1130
net comm. acres	119	219	306	281	+ 87
net indust. acres	115	109	175	162	+ 66
(b) Total "committed acres	2078	2336	2516	2491	+ 180
ext. indust.	262	262	262	262	0
ext. institut.	0	0	0	0	0
streets/hwys	518	776	886	868	+ 110
restr. open space	1298	1298	1368	1361	+ 70
(c) Vacant avail. acres	13940	13053	11588	11756	- 1465
(d) Vacant avail. but unsuit. for devel.	n.a.	8068	8068	8068	0
(e) Vacant, avail, suitable	n.a.	4985	3520	3688	- 1465
(f) Total Developable (a+e)	n.a.	6876	6696	6722	- 180
(g) Est. sewered of all (f)	n.a.	619	1473	1479	+ 854
% sewered of total developable acres (g ÷ f)	n.a.	9	22	22	+ 13
% "used" of total developable acres (a ÷ f)	n.a.	28	47	45	+ 19
Res. Density (HH/Acre)	n.a.	3	3	3	0

HOLLISTON (038)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	6222	12069	17639	16670	+ 5570
RPC	6222	12069	19300	18100	+ 7231
HOUSEHOLDS	1690	3151	4741	4479	+ 1590
EMPLOYMENT - TOTAL	985	1659	4004	3328	+ 2345
- in "wet" or "very wet" mfg.	88	162	363	294	+ 201
TOTAL ACRES (a+b+c)	12224	12224	12224	12224	0
(a) Total "used" acres	1044	1942	3155	3099	+ 1213
net res. acres	867	1617	2684	2578	+ 1067
net comm. acres	118	239	328	301	+ 89
net indust. acres	59	87	143	130	+ 56
(b) Total "committed acres					
ext. indust.	243	243	243	243	0
ext. institut.	0	0	0	0	0
streets/hwys	293	401	541	522	+ 140
restr. open space	1696	1696	1764	1757	+ 68
(c) Vacant avail. acres	8949	7943	6522	6693	- 1421
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	7943	6522	6693	- 1421
(f) Total Developable (a+e)	n.a.	9885	9677	9792	- 208
(g) Est. sewered of all (f)	n.a.	0	2419	2448	+ 2419
% sewered of total developable acres (g ÷ f)	n.a.	0	25	25	+ 25
% "used" of total developable acres (a ÷ f)	n.a.	20	33	32	+ 13
Res. Density (HH/Acre)	n.a.	2	2	2	0

HOPKINTON (039)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	4932	5981	10769	10005	+ 4788
RPC	4932	5981	13600	14400	+ 7619
HOUSEHOLDS	1337	1700	3158	2933	+ 1458
EMPLOYMENT - TOTAL	365	769	6487	6053	+ 5718
- in "wet" or "very wet" mfg.	7	10	0	0	- 10
- commercial empl.	253	471	4000	4000	+ 3529
TOTAL ACRES (a+b+c)	17869	17869	17869	17869	0
(a) Total "used" acres	722	972	2100	2030	+ 1128
net res. acres	665	845	1625	1568	+ 780
net comm. acres	43	80	316	316	+ 236
net indust. acres	13	46	159	146	+ 113
(b) Total "committed acres					
ext. indust.	263	263	263	263	0
ext. institut.	5	5	5	5	0
streets/hwys	323	535	686	677	+ 151
restr. open space	3031	3031	3081	3077	+ 50
(c) Vacant avail. acres	13526	13064	11735	11817	- 1329
(d) Vacant avail. but unsuit. for devel.	n.a.	8068	8068	8068	0
(e) Vacant, avail, suitable	n.a.	4996	3667	3749	- 1329
(f) Total Developable (a+e)	n.a.	5968	5767	5779	- 201
(g) Est. sewered of all (f)	n.a.	0	2307	2312	+ 2307
% sewered of total developable acres (g ÷ f)	n.a.	0	40	40	+ 40
% "used" of total developable acres (a ÷ f)	n.a.	16	36	35	+ 20
Res. Density (HH/Acre)	n.a.	2	3	3	+ 1

MARLBOROUGH (051)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	18819	27936	36075	34490	+ 8139
RPC	18819	27936	34000	38300	+ 6064
HOUSEHOLDS	5608	8293	11101	10606	+ 2808
EMPLOYMENT - TOTAL	4157	7305	12059	10438	+ 4754
- in "wet" or "very wet" mfg.	434	329	465	380	+ 136
-`commercial emp.	1564	3712	5890	5237	+ 2178
TOTAL ACRES (a+b+c)	14106	14106	14106	14106	0
(a) Total "used" acres	1789	2896	3920	3757	+ 1024
net res. acres	1440	2129	2883	2796	+ 754
net comm. acres	253	600	745	702	+ 145
net indust. acres	97	168	292	259	+ 124
(b) Total "committed acres					
ext. indust.	230	230	230	230	0
ext. institut.	1	1	1	1	0
streets/hwys	559	692	826	802	+ 134
restr. open space	1409	1409	1455	1449	+ 46
(c) Vacant avail. acres	10117	8877	7674	7867	- 1203
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	8877	7674	7867	- 1203
(f) Total Developable (a+e)	n.a.	11773	11594	11624	- 179
(g) Est. sewered of all (f)	n.a.	2590	5565	5580	+ 2975
% sewered of total developable acres (g ÷ f)	n.a.	22	48	48	+ 26
% "used" of total developable acres (a ÷ f)	n.a.	25	34	32	+ 9
Res. Density (HH/Acre)	n.a.	4	6	6	+ 2

MEDFIELD (054)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	6021	9821	16738	15729	+ 6917
RPC	6021	9821	18200	15700	+ 8379
HOUSEHOLDS	1251	2342	4279	4007	+ 1937
EMPLOYMENT - TOTAL	553	1051	4857	4085	+ 3806
- in "wet" or "very wet" mfg.	0	17	0	0	- 17
TOTAL ACRES (a+b+c)	9293	9293	9293	9293	0
(a) Total "used" acres	894	1673	3188	3065	+ 1515
net res. acres	790	1488	2782	2687	+ 1294
net comm. acres	97	181	283	283	+ 102
net indust. acres	7	5	124	96	+ 119
(b) Total "committed acres					
ext. indust.	184	184	184	184	0
ext. institut.	0	0	0	0	0
streets/hwys	259	352	531	516	+ 179
restr. open space	1664	1664	1754	1747	+ 90
(c) Vacant avail. acres	6292	5419	3636	3781	- 1783
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	5419	3636	3781	- 1783
(f) Total Developable (a+e)	n.a.	7092	6824	6846	- 268
(g) Est. sewered of all (f)	n.a.	213	3753	3765	+ 3540
% sewered of total developable acres (g ÷ f)	n.a.	3	55	55	+ 52
% "used" of total developable acres (a ÷ f)	n.a.	24	45	45	+ 21
Res. Density (HH/Acre)	n.a.	2	2	2	0

MEDWAY (056)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	5168	7829	11092	10511	+ 3263
RPC	5168	7829	12300	10100	+ 4441
HOUSEHOLDS	1459	2135	3068	2906	+ 933
EMPLOYMENT - TOTAL	688	1049	3792	3105	+ 2743
- in "wet" or "very wet" mfg.	129	78	158	130	+ 80
TOTAL ACRES (a+b+c)	7462	7462	7462	7462	0
(a) Total "used" acres	845	1288	1886	1799	+ 598
net res. acres	763	117	1539	1495	+ 422
net comm. acres	52	95	210	178	+ 115
net indust. acres	29	76	137	126	+ 61
(b) Total "committed acres					
ext. indust.	214	214	214	214	0
ext. institut.	0	0	0	0	0
streets/hwys	214	267	346	333	+ 79
restr. open space	487	487	518	514	+ 31
(c) Vacant avail. acres	5702	5205	4498	4602	- 707
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	5205	4498	4602	0
(f) Total Developable (a+e)	n.a.	6494	6384	6401	- 707
(g) Est. sewered of all (f)	n.a.	130	2234	2240	+ 2104
% sewered of total developable acres (g ÷ f)	n.a.	2	35	35	+ 33
% "used" of total developable acres (a ÷ f)	n.a.	20	30	28	+ 10
Res. Density (HH/Acre)	n.a.	2	3	3	+ 1

MILFORD (059)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	15749	19352	22165	21427	+ 2813
RPC	15749	19352	25800	24500	+ 6448
HOUSEHOLDS	4796	6370	7313	7067	+ 943
EMPLOYMENT - TOTAL	4588	4514	4583	4107	+ 69
- in "wet" or "very wet" mfg.	163	184	323	270	+ 139
TOTAL ACRES (a+b+c)	9594	9594	9594	9594	0
(a) Total "used" acres	1424	1770	2064	1972	+ 294
net res. acres	1087	1444	1747	1679	+ 303
net comm. acres	155	231	203	189	- 28
net indust. acres	183	95	114	104	+ 19
(b) Total "committed acres					
ext. indust.	195	195	195	195	0
ext. institut.	0	0	0	0	0
streets/hwys	491	714	746	733	+ 32
restr. open space	621	621	633	630	+ 11
(c) Vacant avail. acres	6863	6294	5956	6063	- 338
(d) Vacant avail. but unsuit. for devel.	n.a.	3818	3818	3818	0
(e) Vacant, avail, suitable	n.a.	2476	2138	2245	- 338
(f) Total Developable (a+e)	n.a.	4246	4202	4217	- 44
(g) Est. sewered of all (f)	n.a.	1359	1471	1476	+ 112
% sewered of total developable acres (g ÷ f)	n.a.	32	35	35	+ 3
% "used" of total developable acres (a ÷ f)	n.a.	42	49	47	+ 7
Res. Density (HH/Acre)	n.a.	4	4	4	0

MILLIS (060)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	4374	5795	11141	10347	+ 5346
RPC	4374	5795	13000	10600	+ 7205
HOUSEHOLDS	1180	1513	3076	2855	+ 1563
EMPLOYMENT - TOTAL	999	1049	2974	2881	+ 1925
- in "wet" or "very wet" mfg.	204	387	575	481	+ 188
TOTAL ACRES (a+b+c)	7846	7846	7846	7846	0
(a) Total "used" acres	704	876	1702	1646	+ 826
net res. acres	560	718	1432	1385	+ 714
net comm. acres	40	60	148	148	+ 88
net indust. acres	104	98	122	114	+ 24
(b) Total "committed acres					
ext. indust.	81	81	81	81	0
ext. institut.	16	16	16	16	0
streets/hwys	231	252	348	341	+ 96
restr. open space	1177	1177	1229	1226	+ 52
(c) Vacant avail. acres	5637	5444	4470	4536	- 974
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	5444	4470	4536	- 974
(f) Total Developable (a+e)	n.a.	6320	6172	6182	- 148
(g) Est. sewered of all (f)	n.a.	379	3395	3400	+ 3016
% sewered of total developable acres (g ÷ f)	n.a.	6	55	55	+ 49
% "used" of total developable acres (a ÷ f)	n.a.	14	28	27	+ 14
Res. Density (HH/Acre)	n.a.	2	3	3	+ 1

SOUTHBOROUGH (087)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	3996	5798	9750	9133	+ 3952
MPC	3996	5798	10600	11300	+ 4802
HOUSEHOLDS	1142	1553	2698	2526	+ 1145
EMPLOYMENT - TOTAL	656	1308	2657	2112	+ 1349
- in "wet" or "very wet" mfg.	193	7	22	13	+ 15
TOTAL ACRES (a+b+c)	9869	9869	9869	9869	0
(a) Total "used" acres	864	1617	2107	2052	+ 490
net res. acres	638	867	1304	1270	+ 437
net comm. acres	201	719	714	732	- 5
net indust. acres	25	31	62	51	+ 31
(b) Total "committed acres					
ext. indust.	139	139	139	139	0
ext. institut.	0	0	0	0	0
streets/hwys	333	424	480	472	+ 56
restr. open space	1256	1256	1283	1281	+ 27
(c) Vacant avail. acres	7277	6433	5860	5925	- 573
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	6433	5860	5925	- 573
(f) Total Developable (a+e)	n.a.	8050	7967	7977	- 83
(g) Est. sewered of all (f)	n.a.	0	2390	2393	+ 2390
% sewered of total developable acres (g ÷ f)	n.a.	0	30	30	+ 30
% "used" of total developable acres (a ÷ f)	n.a.	20	26	26	+ 6
Res. Density (HH/Acre)	n.a	2	4	4	+ 2

WESTBOROUGH (102)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	9599	12594	18327	17414	+ 5733
MPC	9599	12594	21900	21900	+ 9306
HOUSEHOLDS	2188	3619	5528	5224	+ 1909
EMPLOYMENT - TOTAL	2162	5170	9622	7667	+ 4452
- in "wet" or "very wet" mfg.	1086	1338	686	513	- 652
TOTAL ACRES (a+b+c)	13766	13766	13766	13766	0
(a) Total "used" acres	1260	3040	3993	3848	+ 953
net res. acres	781	1292	2018	1952	+ 726
net comm. acres	390	893	992	964	+ 99
net indust. acres	89	854	983	932	+ 129
(b) Total "committed acres					
ext. indust.	211	211	211	211	0
ext. institut.	0	0	0	0	0
streets/hwys	495	708	830	807	+ 122
restr. open space	1891	1891	1935	1931	+ 44
(c) Vacant avail. acres	9909	7917	6797	6969	- 1120
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	7917	6797	6969	- 1120
(f) Total Developable (a+e)	n.a.	10956	10790	10817	- 166
(g) Est. sewered of all (f)	n.a.	767	5934	5949	+ 5167
% sewered of total developable acres (g ÷ f)	n.a.	7	55	55	+ 48
% "used" of total developable acres (a ÷ f)	n.a.	28	37	36	+ 9
Res. Density (HH/Acre)	n.a.	3	4	4	+ 1

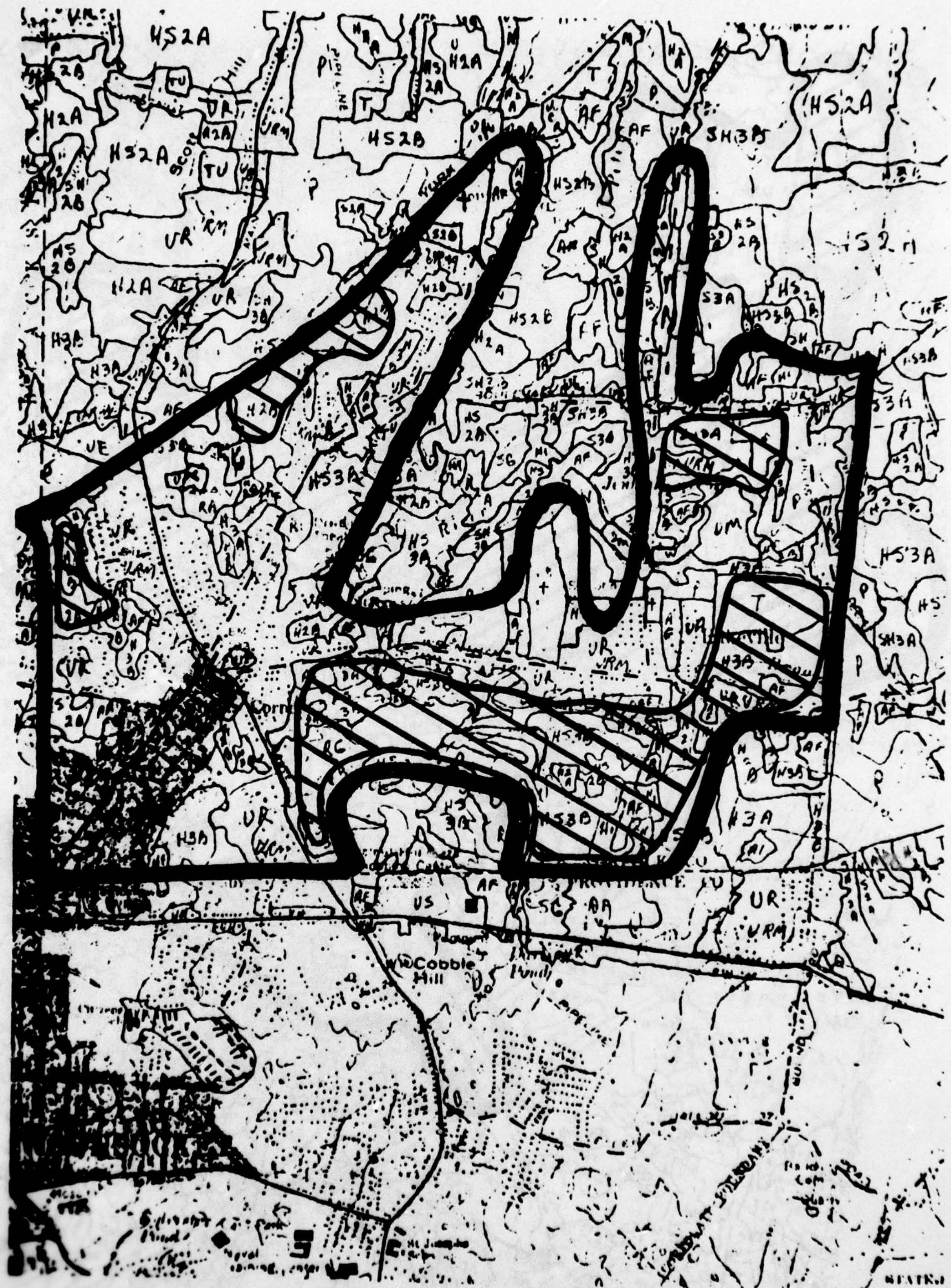
WRENTHAM (111)

	1960	1970	1990 - Projected High	1990 - Projected Low	Change 1970-1990 High
POPULATION					
M/E	6685	7494	11513	10861	+ 4019
RPC	6685	7494	22400	20000	+ 14906
HOUSEHOLDS	1280	1580	2902	2705	+ 1322
EMPLOYMENT - TOTAL	1163	1630	4360	3725	+ 2730
- in "wet" or "very wet" mfg.	0	19	0	0	- 19
TOTAL ACRES (a+b+c)	14515	14515	14515	14515	0
(a) Total "used" acres	1006	1343	2183	2100	+ 840
net res. acres	750	926	1634	1584	+ 708
net comm. acres	227	317	389	367	+ 72
net indust. acres	29	100	160	149	+ 60
(b) Total "committed acres					
ext. indust.	329	329	329	329	0
ext. institut.	0	0	0	0	0
streets/hwys	278	318	418	407	+ 100
restr. open space	1210	1210	1210	1210	0
(c) Vacant avail. acres	11692	11314	10375	10459	- 939
(d) Vacant avail. but unsuit. for devel.	n.a.	0	0	0	0
(e) Vacant, avail, suitable	n.a.	11314	10375	10469	- 939
(f) Total Developable (a+e)	n.a.	12657	12558	12569	- 99
(g) Est. sewered of all (f)	n.a.	0	2763	2765	+ 2763
% sewered of total developable acres (g ÷ f)	n.a.	0	22	22	+ 22
% "used" of total developable acres (a ÷ f)	n.a.	11	18	17	+ 7
Res. Density (HH/Acre)	n.a.	2	3	3	+ 1

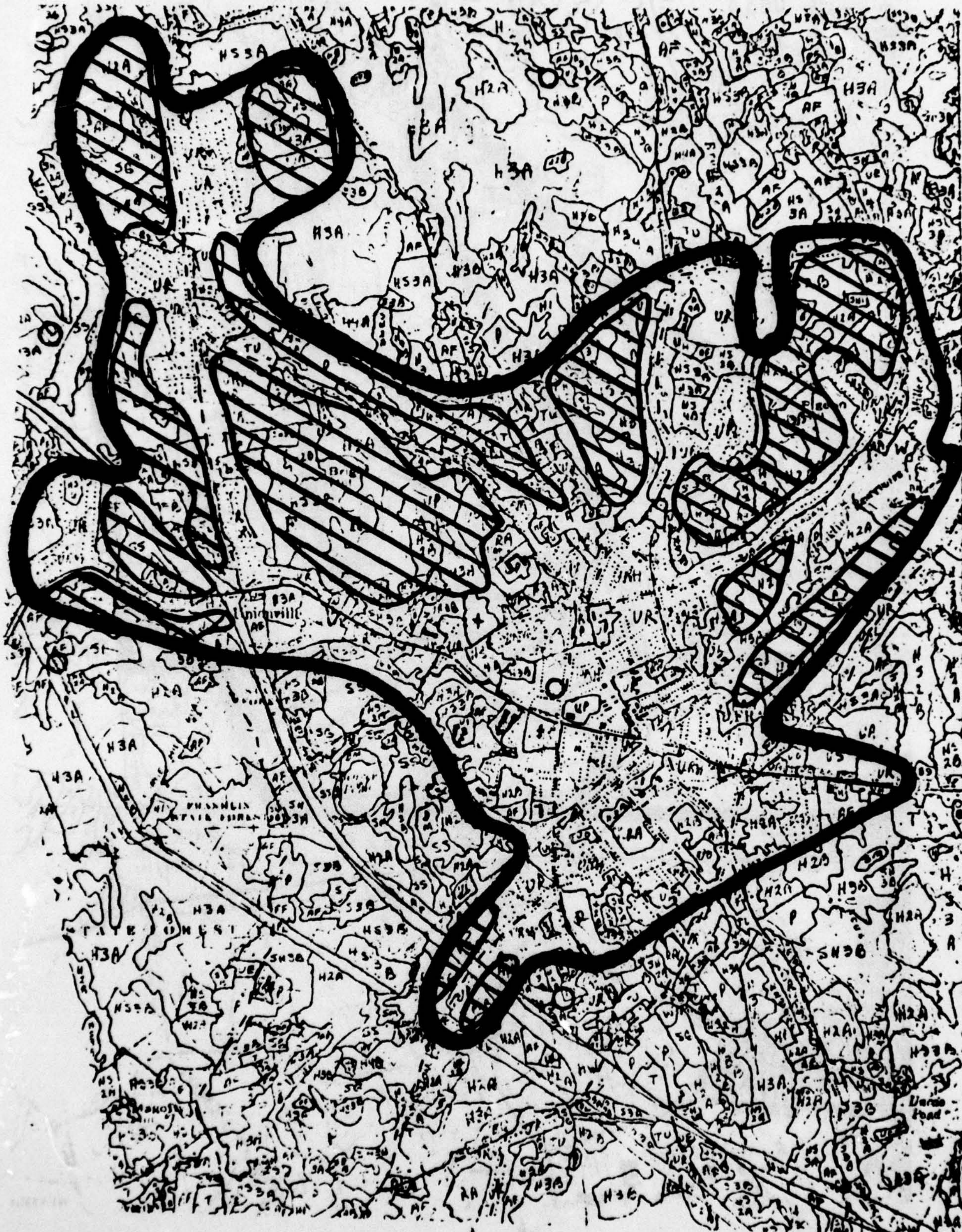
APPENDIX 11.2

Maps attached show proposed areas for sewering (Camp, Dresser, McKee). Shaded areas on the map are currently undeveloped land within the proposed area for sewering. Land use codes can be found on MAPC land use code interpretation sheets attached.

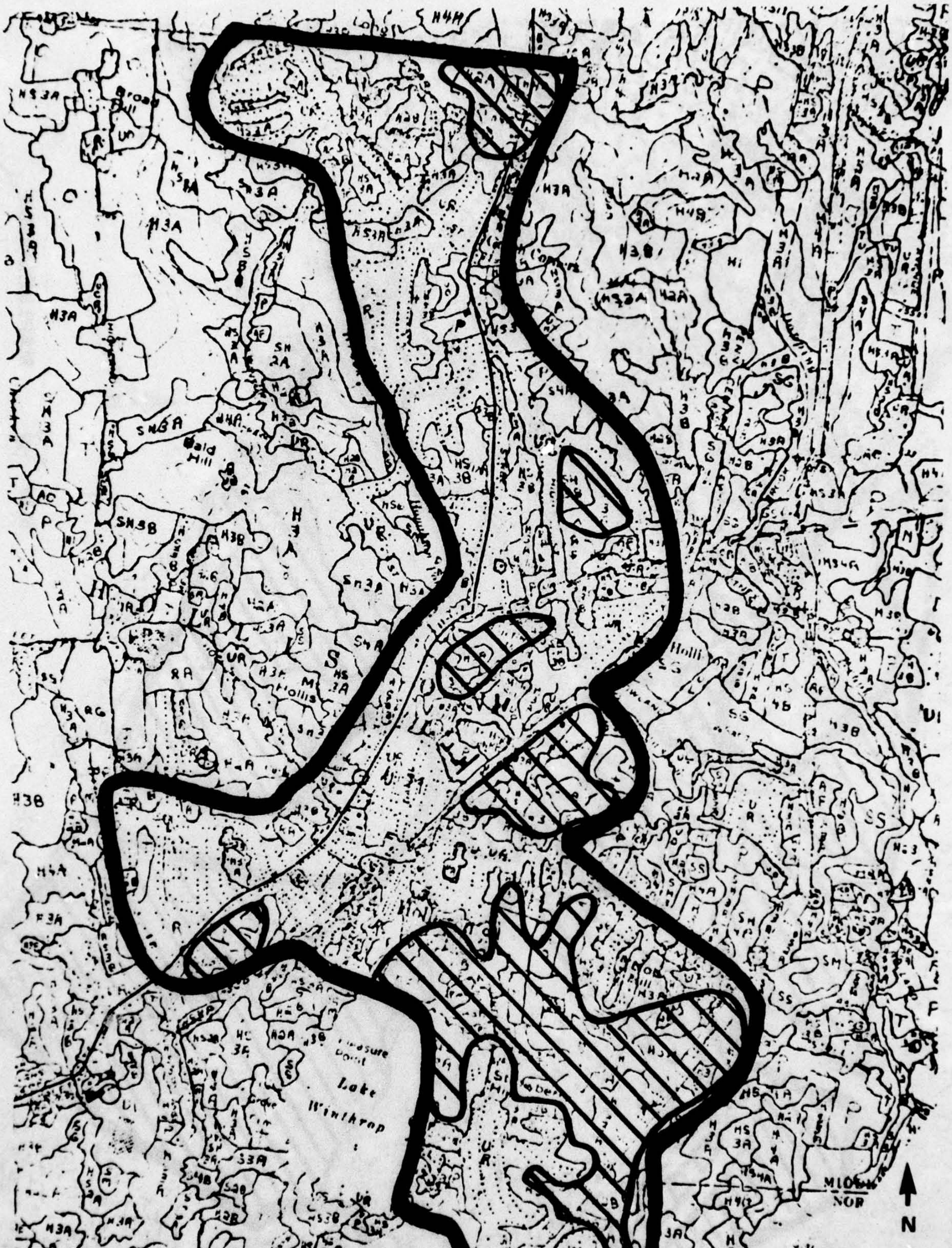

N
MAP
NORTH BELLINGHAM



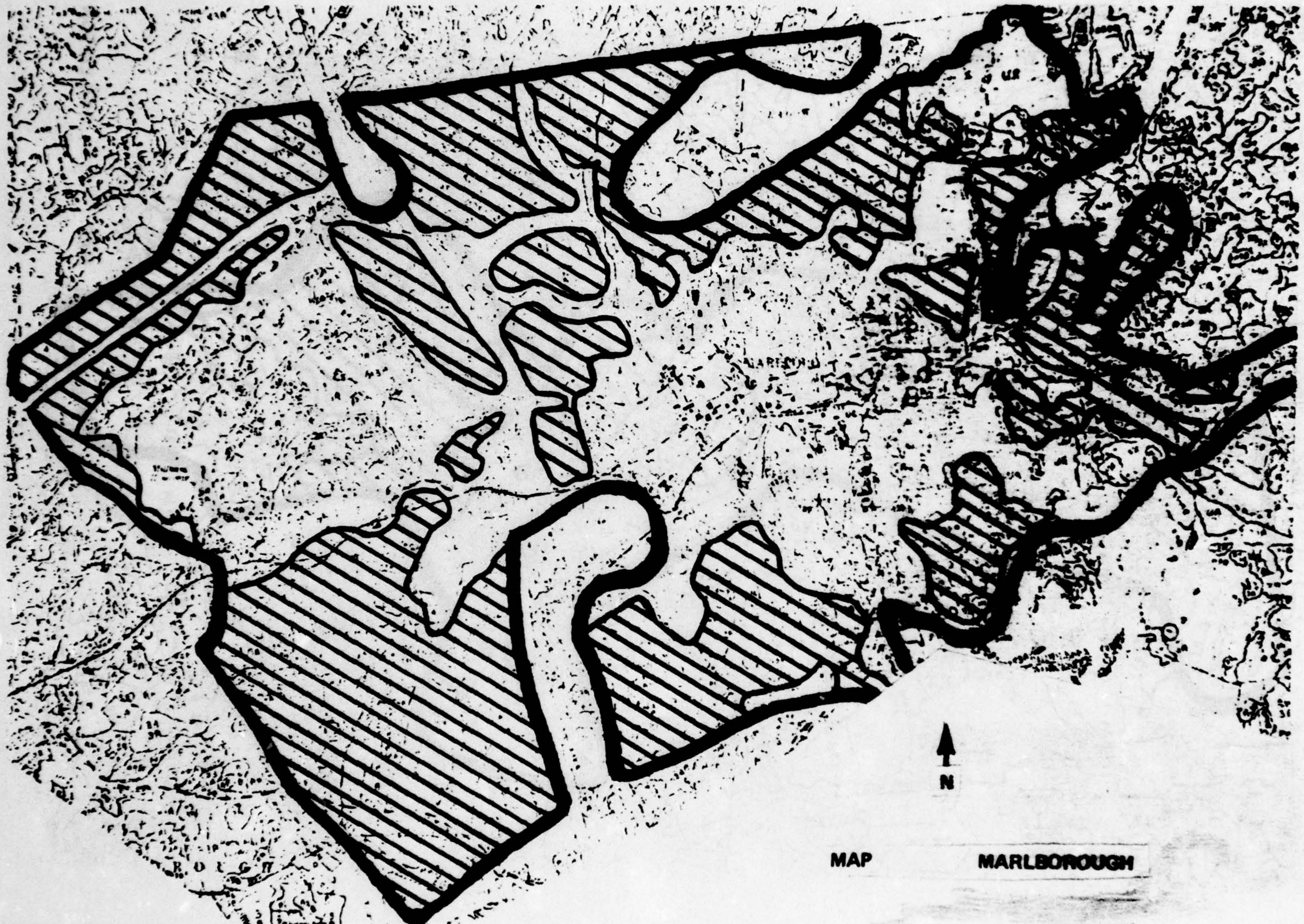
N MAP SOUTH BELLINGHAM



N MAP FRANKLIN



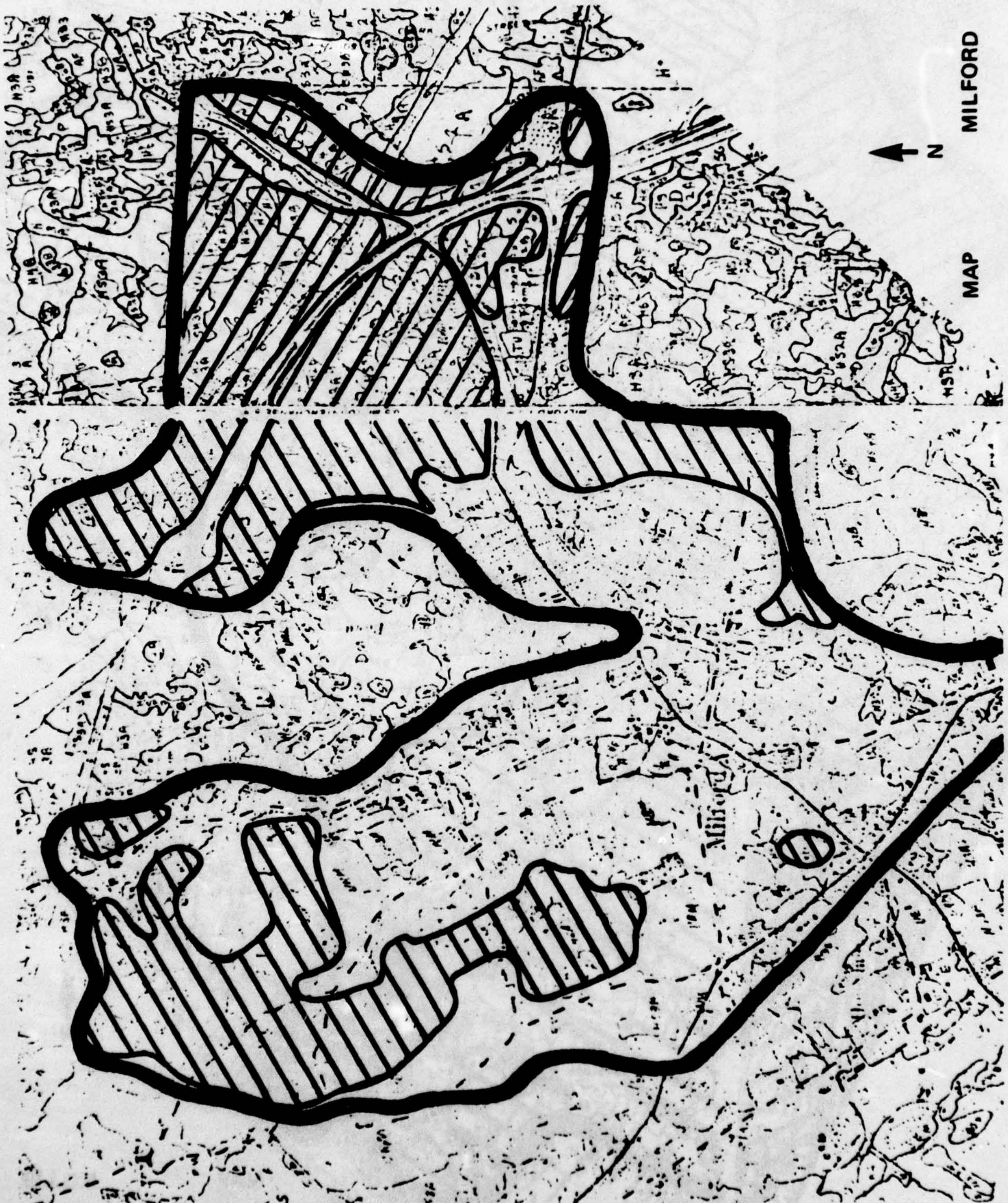
MAP HOLLISTON

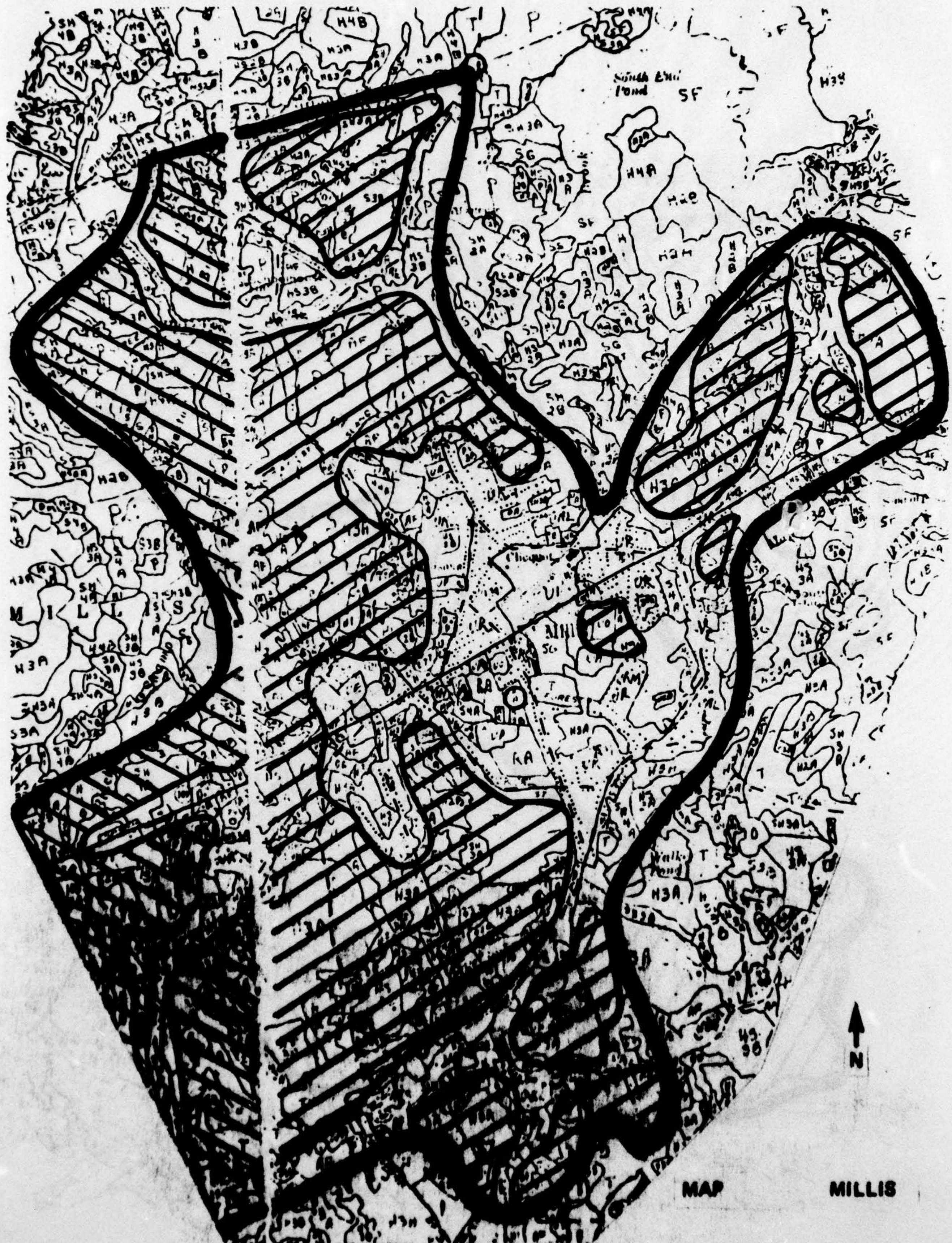


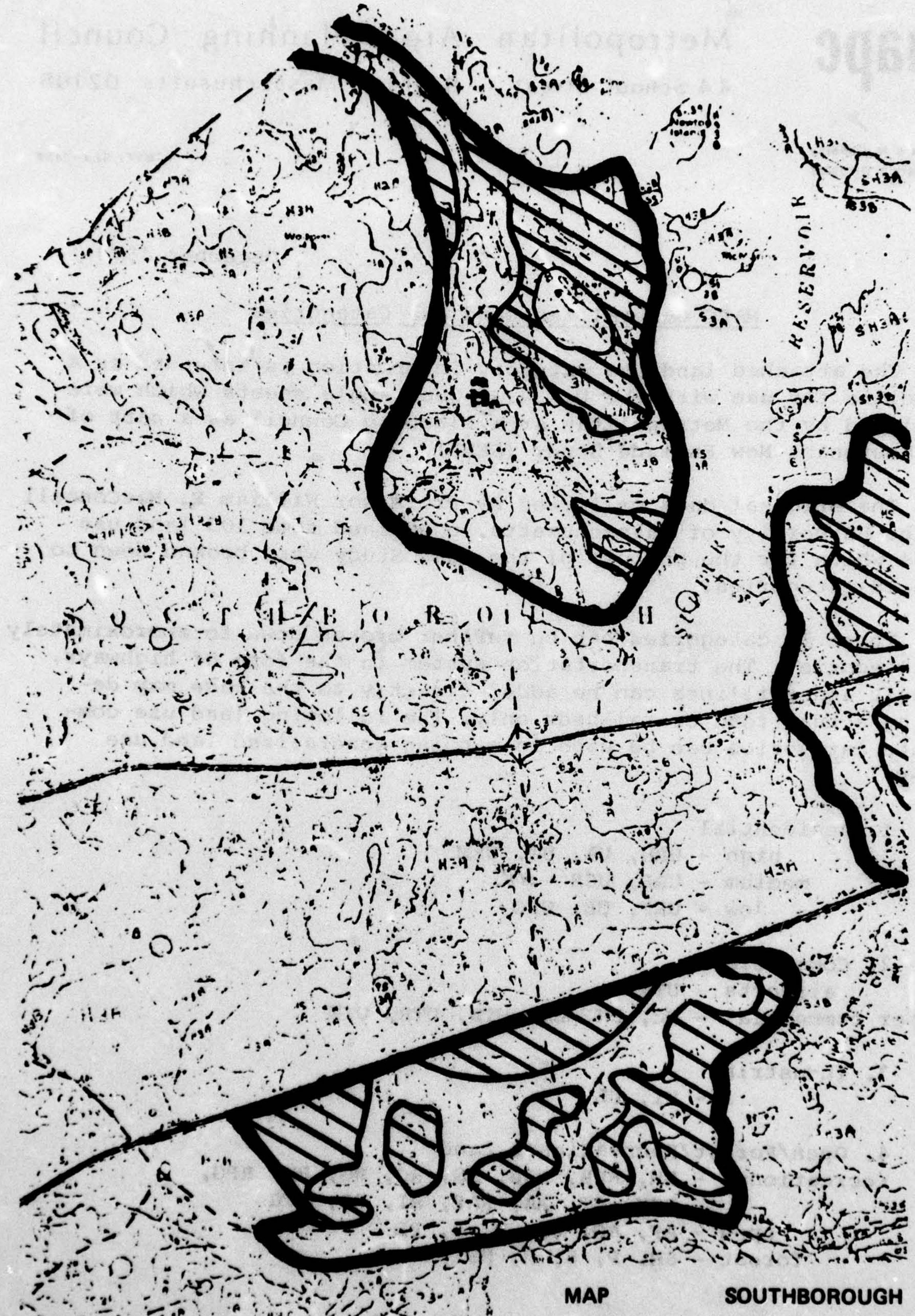
MAP MARLBOROUGH

MAP MEDFIELD

MAP MEDWAY


MAP MILFORD
N
Milford


MAP
MILLIS
N



MAP SOUTHBOROUGH

mapc Metropolitan Area Planning Council

44 School Street Boston, Massachusetts 02108

Richard M. Doherty
Executive Director

(617) 523-2454

December 1973

MAPC Generalized Land Use Categories

The attached land use category information is intended as a guideline for use with the U.S.G.S. Quadrangle sheets which were completed by the Metropolitan Area Planning Council as a part of the Southeast New England Study (SENE).

The original data collected by Professor William P. MacConnell of the University of Massachusetts, contained some 103 land use types which for the purpose of the SENE Study were broken down to some 18 categories.

These 18 categories can be further broken down to approximately 10 categories. The transportation system in the form of highways, transit and raillines can be added directly to the base map defining actual road or railbeds only. The following land use composite categories can be used in mapping generalized land use types:

1. Residential
   - high - URH, UA, UT, URM
   - medium - URL, UCR - UR
   - low - URF, UE, URO

2. Commercial
   - airports - UTA
   - other commercial - UC, UH, US, UTW, UTR, UTT

3. Industrial
   - - UI, UL

4. Open/Forest/Recreational Land
   - recreational - RM, RFB, RSB, RS, RC, RG, RD, RPG, RSK, RT, RA, RAP, RI, RP, RFG
   - open - AF, AO, ~~UR~~, H, S, PL
   - forest - SH, P, S, H, HS

5. Agricultural
- T, TU, O, N, CB, P

6. Marshland
- TSM, ISM, DSM, SF, B, SS, M, SM, DM, BP

7. Disposal
sewage - FB
refuse - D, DA

8. Water Bodies
- W

9. Extractive
- SG, OM

10. Institutional
- UP, +

Standard land use colors are:

Residential - yellow
Commercial - red
Industrial - purple
Open/Forest/Recreational - green
Agricultural - white
Marshland - light green
Disposal - brown
Water Bodies - light blue
Extractive - gray
Institutional - medium or dark blue

BACKGROUND INFORMATION
1971 LAND USE & VEGETATIVE COVER
MAPPING
Remote Sensing Twenty Years of Change in the
Human Environment in Massachusetts
1951 - 1971

the
Massachusetts Agricultural
Experiment Station
&
Department of Forestry and
Wildlife Management

Objectives:

a. To develop and test the use of aerial photogrammetric techniques as a tool for identifying and classifying agricultural, forest and wet lands; mining and waste disposal areas, as well as urban land and outdoor recreation sites.

b. To examine and classify the entire state of Massachusetts on new aerial photography and prepare a catalogue of maps covering the entire state for use by resource planners and others requiring detailed maps of the landscape and cityscape in Massachusetts.

c. To determine changes in vegetation and land use which have taken place since the state was photographed and mapped in 1951 and 1952 by a similar system.

d. To establish predictions of future rates and patterns of change for major land-use types based on changes over the past twenty years. Population growth and construction of transportation facilities will be used to help predict future change.

e. To analyze and compare the wet lands of the state on 1951 maps and photographs with those on 1971 maps and photographs to measure changes in area, location and character of wet lands, and especially to expose the impact of urbanization, highway construction and waste disposal areas on the location and extent of these lands.

f. To provide vegetative cover and land-use maps of the entire state for watershed managers, foresters, wildlife biologists, resource planners, and others interested in the environment.

g. To develop visual-aesthetic criteria for describing the scenic quality of the vegetative and land-use types spread on the landscape.

h. To establish a data bank in computer form to store, manipulate, retrieve and present information in tabular or computer map form from the maps made in the 1951 study as well as those made from 1971 aerial photography and those made from ERTS/EROS imagery.

i. To study urban growth and decay, especially the situation in the urban-agriculture or urban-forest interface in Massachusetts.

j. To provide ground truth for training in interpretation of ERTS/EROS imagery.

Procedure: The general procedure will be to:

a. Acquire new aerial photography of the state at a scale of 1:20, 000.

b. Refine and adapt the aerial photographic classification used for Massachusetts and for the entire Connecticut River as well as on-going research in urban land classification for use in mapping the state in this project.

c. Interpret the new aerial photographs of the state and annotate them with the land-use and vegetative types in the classification systems evolved for the state.

Six categories will be recognized:

1. Agricultural or open land
2. Forest land
3. Fresh and salt water wet lands
4. Mining and waste disposal areas
5. Urban lands
6. Outdoor recreation facilities

d. Transfer this information to USGS maps adding new roads, buildings and other important information.

e. Print 100 copies of each map for interested state and federal agencies.

f. Establish a data bank in computer form and manipulate the map information to bring to light changes and trends in the extent, character and location of the more interesting types.

g. Prepare statistical summaries of this information by towns, counties and for the state.

h. Compare the situation on maps and in area statistics determined from 1951-1952 photographs with the new maps and statistics generated by this project.

i. Make predictions of future changes based on past changes, population shifts, highway construction and other factors.

j. Analyze and interpret changes in land use and vegetative types as they are related to demographic, socio-economic, and ecological factors. This work will involve several co-investigators from various departments, who are now working with us on an ongoing wetlands project.

k. Use the type maps as ground truth for the ERTS/EROS imagery which will become available in 1972.

l. Train photo interpreters to use satellite imagery to monitor the environment on a short-term basis.

AD-A036 810 METCALF AND EDDY INC BOSTON MASS F/G 13/2

WASTEWATER ENGINEERING AND MANAGEMENT PLAN FOR BOSTON HARBOR - --ETC(U)

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Classification System

Original 103 Categories: The land-use classification system has six categories which are described below. The minimum sized typing unit is determined by the map manuscript scale and that size is five acres.

Agricultural or Open Lands (10 types)

One way to classify agricultural and open land is by the vegetation which it supports. To a degree, vegetative cover defines the land value and its potential for other uses. Vegetative cover is the basis of agricultural land classification in this study. Soil types would be more valuable for this purpose but they are very difficult to determine on aerial photographs.

T - is tilled or tillable crop land which is or has recently been intensively farmed. The boundaries are sharply defined and well maintained because the land is valuable. The land supporting farm buildings is included as part of this type.

TU - is unused tillable land which has not been tilled for five years or more and is not part of an agricultural unit. This kind of land occurs most often near growing urban areas.

P - is pasture or wild hay land which is not suitable for tillage due to steepness of slope, poor drainage, stoniness, or lack of fertility. This land has less sharply defined boundaries and often has occasional scattered shade trees for the grazing animals. Livestock or the evidence of livestock uses is often present.

AF - is abandoned field which is reverting to wild land. Woody vegetation and grass are abundant but tree crown cover is less than 30%. If the crown cover were greater than 30%, the land would be classified as forest. This land may be grazed by domestic animals and it is highly productive of wildlife.

O - is fruit orchard.

AO - is abandoned orchard. In addition to the decadent fruit trees, grass and woody vegetation are abundant in this type.

CB - is cranberry bog.

N - is land supporting nurseries. This type would include greenhouses and land adjacent to them as well as lands supporting horticultural specialties, ornamentals, shrubs and Christmas tree plantations.

S - is sand areas which may support scattered herbaceous vegetation. Sandy beaches are a separate outdoor recreation type.

PL - is powerlines or other maintained rights-of-way 100 feet or more in width for buried telephone lines or gas or oil pipe lines, or lands occupied by electric transformers. Powerlines are indicated as agricultural land where they are used for that purpose.

Forest Lands - 40 types

Forested land is classified by a system which describes the forest by species, height and density. Species differentiation is necessary because some species have greater value for lumber, for wildlife habitat, or a greater resistance to recreational impact than do others. Height indicates tree size, while density determines light conditions under the stand and the likelihood of lesser vegetation under it.

Species groups are designated by letters as follows:

S - softwoods constitute at least 80 percent of the stand.

H - hardwoods constitute at least 80 percent of the stand.

HS - a mixture of hardwoods and softwoods with hardwoods predominating.

SH - a mixture of softwoods and hardwoods with softwoods predominating.

P - plantations are indicated by appending the symbol P to the forest type symbol.

The Height classes used were:

1. 1 ft. - 20 ft.
2. 21 ft. - 40 ft.
3. 41 ft. - 60 ft.
4. 61 ft. - 80 ft.
5. 81 ft. -100 ft.
6. Uneven heights (three or more height classes represented)

The density classes were:

A. High density, 81 to 100 percent crown closure.
B. Low density, 51 to 80 percent crown closure.
C. Very low density, 30 to 50 percent crown closure.

Density classes are not applied to one height class trees. This code method of classifying or typing forest stands lists species, height, and then density as in the following examples:

H2A is a hardwood stand 21 to 40 feet in height with high density.

HS5A is a mixture of hardwoods and softwoods with hardwoods predominating. The stand is 81 to 100 feet tall with high density.

Wet Lands - 11 types

The wet land classification is a modification of that used by the Office of River Basins of the U. S. Fish and Wildlife Service. Their classification was simplified so that wet land separation could be accurately made on 1:20,000 scale areal photographs. Wet lands are highly productive of wildlife.

SF - is seasonally flooded basins or flats. The soil is waterlogged or covered with water during spring freshets, but well-drained during the growing season. This type occurs principally on stream floodplains and the most common plants are grasses and herbaceous species.

B - is bog. The typically acid, peaty soil is waterlogged and supports a distinctive plant community which usually includes most of the following: heath shrubs, cranberries, pitcher plants and sedges. Scattered black spruce, tamarack and red maple may be present. A mat of sphagnum moss is the most characteristic feature of bogs.

SS - is shrub swamp. The soil is waterlogged during the growing season and is often covered with as much as six inches of water. Common woody species are alder, buttonbush, dogwood and willow. Sedges are usually present in tussocks.

M - is meadow. The soil is waterlogged through most of the growing season and surface water is present only for a short period during the spring. Vegetation is predominantly grasses, rushes and sedges. Rushes, which grow in the wetter parts of many meadows, photograph very darkly making this type easy to identify.

SM - is shallow marsh. This type is wetter than meadow. The soil is completely waterlogged and often covered with up to six inches of water during the growing season. There is usually some open water and the predominant vegetationis emergent, including such plants as cattails, bulrushes, burreed, pickerelweed and arrowhead with some grasses and sedges present.

DM - is deep marsh. Water depth ranges from six inches to three feet. Fairly large open water areas are bordered by, or interspersed with, emergent vegetation like that found in shallow marsh. Floating and submergent plants such as water lilies, duckweed, watershield and pondweeds are also present.

W - is fresh open water in lakes and large streams. Water depth is greater than three feet during the growing season.

BP - is beaver pond. These ponds resemble one or more of the above types but they owe their origin to beaver.

TSM- is tidal salt water which is flooded twice daily. Vegetation is primarily saltmarsh cordgrass.

ISM- is irregularly flooded salt meadows, flooded at monthly high tides and during severe storms. Vegetation is primarily saltmeadow cordgrass, saltgrass and black rush.

DSM- is irregularly flooded salt meadow which has been ditched for mosquito control or for agricultural purposes.

Wooded swamps are designated by forest type symbols and the swamp situation is shown by swamp symbols on the U.S.G.S. map. Areas for wooded swamps are not kept separate from other forested areas.

Mining or Waste Disposal Areas - 5 types

Mining in the state of Massachusetts is mainly for sand, gravel or stone. Waste disposal occupies much space and may have unsightly characteristics.

SG - Sand or Gravel - This land is used for the extraction of sand or gravel.

OM - Other Mining - This land is used for the extraction of stone and materials other than sand or gravel. Mining sites, though ugly to most, are fascinating to rock collectors.

D - Dump - This land is used for dumping waste and refuse materials such as tin cans. Active sanitary land fills would fall into this class.

DA - Automobile Dumps - Automobile graveyards or active automobile junk yards.

FB - Filter Bed - This is land and associated buildings used for treating liquids containing organic or chemical matter.

Urban Land - 18 types

Land classified as urban encompasses a large number of people living and working in closely ordered structures in a confined land space. Its limits are at the border of the block street pattern or just beyond it. Each urban type includes the access roads, parking facilities and other features which go with the complex. The following system will be used to classify urban area in towns with less than 50,000 inhabitants. A more complex system will be used on cities with over 50,000 inhabitants.

UI - is heavy industrial land containing facilities for the manufacture, storage and assembly of raw or partially processed products such as machinery, metals, chemicals, petroleum, or electrical power. Such industries often have large smokestacks and large storage areas. Warehouses and transportation facilities for bulk products and an open and interrupted street pattern characterize this type. Air and water pollution as well as unsightliness are often characteristics of heavy industry. Very few people live here.

UL - is light industrial land containing facilities for the manufacture or assembly of smaller, partially processed products such as electronics, appliances, and other secondary process products. Large smokestacks or raw material storage facilities are never present, air and water pollution are seldom a problem, and light industries are not apt to be unsightly. Many modern light industries are indistinguishable from commercial activity.

UC - is urban core commercial land predominantly used for distribution, or merchandising goods and services. Stores, hotels, offices, parking garages, apartment buildings and smaller warehouses are usually set close to streets having a close pattern. Trees are rare in commercial areas. Most of the city people not living in residential areas, garden apartments or "town houses" live here.

UH - is highway commercial land used for merchandising goods and services to the traveling public away from urban centers. Gas stations, motels, restaurants, drive-ins and stores located in strips along major routes of travel make up this type.

UB - is shopping centers away from the urban core which are surrounded by large parking lots and may have some landscaping and trees as part of the complex.

UP - is public or quasi-public land with "grounds" and green space which contains facilities to serve large numbers of people. Examples are: Schools, colleges, churches, state hospitals, prisons, etc.

UA - is "garden" apartments which are located outside the "core" city, are set back from the street, have some "grounds" and may have attached recreational facilities like swimming pools and tennis courts.

UT - is tenement houses which have a common wall between the separate units. 3 (or more) family, closely spaced buildings fall into this category.

UR - is urban residential land used for homes which are spaced closely, arranged in orderly curved or rectangular patterns and set back from the street. Most of the people live here.

UO - is open undeveloped land which is lying idle in the midst of urban areas or adjacent to them. Such land awaits an opportune time for development.

UCR- is clustered residential land with clusters of three to ten domestic dwellings in farming or forested areas. This type includes homes and related structures such as garages, barns and sheds in a more scattered pattern than on residential land.

UE - is estates with extensive lawns, gardens, shrubs and other "grounds".

UTA- is airports with landing strips, hangers, parking areas and related facilities. Small airfields without runways, hangers or other specialized facilities are not typed as airports.

UTW- is docks, warehouses and related land based facilities for water transportation.

UTR- is railyards, terminal freight and storage facilities as well as rail stations for passengers.

UTT- is terminal freight and storage facilities for truck freight. Bus terminals are included in this type. Transportation facilities which are part of an industrial complex are included as part of the industry and classified UI.

HW - is divided highways with 200 feet or more of right-of way width.

† - is cemeteries. The cross symbols for older cemeteries are already on the U.S.G.S. base map. New cemeteries are added to the map.

Urban Land Cities of 50,000 or More Inhabitants - 40 types

Some of the urban types in the urban core of large cities are separated into age, height and density classes.

Three age classes of industrial (UI and UL), commercial (UC,UL and US), garden apartments (UA) and town houses (UT) are recognized as follows:

1 - 1 year to 25 years old
2 - 26 to 50 years old
3 - over 50 years old

Four height classes are recognized:

A - 1 and 2 story buildings
B - 3 and 4 story buildings
C - 5 to 10 stories
D - 11 or more stories

Four density classes are recognized. Density is based on functioning space like buildings, parking lots, city streets and service roads as opposed to decorative space like turf, gardens, or parks. Four density classes are recognized as follows:

1 - 90 to 100 percent functioning space
2 - 70 to 89 percent functioning space
3 - 50 to 69 percent functioning space
4 - less than 50 percent functioning space

Outdoor Recreational Facilities - 15 types

Outdoor recreation types are water based, facility based, or environmental in character. Each recreational type includes the recreational complex: access roads, parking facilities, buildings and other related facilities. State parks, state forests, or town forests would be typed as forest land.

Water Based Recreation

RM - is marinas.

RFB- fresh water sandy beach.

RSB- salt water sandy beach.

RS - is swimming pools when the complex including bath-houses and parking facilities is five acres or more in size.

Recreation based on facilities

RC - is tennis courts where the complex is five acres or more in size.

RG - is golf courses.

RD - is driving ranges or skeet shooting ranges.

RT - is race tracks for horses, dogs or cars.

RA - is athletic fields and stadiums.

RPG- is playgrounds. A conglomeration of many types of playground facilities which may include tennis courts, swimming pools and athletic fields.

RAP- commercial amusement parks.

RFG- is fairgrounds for agricultural fairs.

RI - is drive-in theaters.

RSK- is ski areas for alpine skiing. This includes ski trails with the wooded space between them as well as the base facilities and parking area.

Environmental recreation

RP - is an urban park or "common"; intensively used "green space" in the city. A zoo would fall in this class.

Application of the Land-use Classification System: Nearly all parts of the system have been applied extensively on 1:20,000 scale panchromatic aerial photographs over long periods of time. Some categories of land use are very easy to recognize by all trained photo interpreters. Agricultural land, mining and waste disposal areas, urban land and outdoor recreation facilities are relatively easy for the trained interpreter to recognize. Wet lands are more difficult to separate while forests are very difficult for all interpreters to classify on aerial photographs. The beginning interpreter should gain experience with the simpler classifications and work up to the more difficult forest and wet land. A continuous cycle of field reconnaissance with photos in hand, followed by analysis of the photographs under the stereoscope, then an additional ground check of the work done will insure accurate photo interpretation and rapidly build the skill of the interpreter.

Everything on the landscape will not fit neatly into the 103 land-use types in the classification system, and many clearly identifiable types are too small to annotate on the aerial photographs or show on the prepared maps. Each of these problems must be handled in a common sense way as the observer "interprets" what he sees into the "language" of the classification system. The language of the system is precise and it should be carefully studied. What is happening out on the land must be well understood in order to recognize the various land-use types.

Composite Categories: (total 18) Land use data for the Massachusetts portion of the SENE Study will be developed from 1:20,000 scale aerial photography taken during the summer of 1971. Aerial photography taken in the spring of 1970 will be used as base data for Rhode Island. The photography will be interpreted by the Department of Forestry and Wildlife Management at the University of Massachusetts, under the direction of Professor William P. MacConnell. A classification system identifying some 103 types of land use is being used at the University. Once the aerial photographs are interpreted, the information is transferred to 1:24,000 scale U.S.G.S. topographic maps. The SENE land Use Planning Group will combine MacConnell's 100 land use types to an abbreviated 18 category classification system. The land use data will be mapped at a scale of 1" = 1 mile. The 18 SENE land use categories are defined by aggregating certain of Progessor MacConnell's 100 land use types. Listed below are the 18 categories, their symbols, a brief description of the categories and the several MacConnell types that make up the major category.

1. Residential One (R1) will include residential areas with 5 or more dwelling units per acre or lot size less than ¼ acre.

URH- is urban residential land used for homes which are spaced closely and arranged in orderly patterns on lots less than ¼ acre in size. Nearly all the street frontage for these building lots is in the vicinity of 50 feet. There are about eight dwelling units per acre. This type also includes seasonal cottages and mobile home parks.

UA - is garden apartments which are usually located outside the core city, are set back from the street, have some grounds and may have recreational facilities such as swimming pools and tennis courts.

UT - is tenements, town or row houses, or apartment buildings set close to streets. Some goods or services are sold here, but the area is predominantly used for high density urban living.

2. Residential Two (R2) will include residential areas with 2-4 dwelling units per acre or lot size ¼-½ acre.

URM- is residential land used for homes on lots which are predominately ¼ or ½ acre in size. Most of the street frontage is 100' in width and there are two to four dwelling units per acre.

3. Residential Three (R3) will include residential areas with 1- 1.9 dwelling units per acre or lot size ½ - 1 acre.

URL- is residential land with lot sizes of more than ½ acre up to and including 1 acre in size most of the lots are one acre in size.

UCR- is clustered residential land with clusters of three to ten domestic dwelling in farming or forested areas.

4. Residential Four (R4) will include residential areas with less than 1 dwelling unit per acre or lot size greater than one acre.

URF- is residential land with lots greater than 1 acre as well as forested residential land with large lots and heavy forest cover. In the latter, only space for the house and a small lawn are cleared in the forest. More than 75% of the forest is left intact in this type.

UE - is estates three acres or more in size with extensive lawns, gardens, shrubs and other grounds.

URO- is residential land with lots greater than one acre in size.

5. Commercial (C) Will include central business districts, neighborhood business centers, strip commercial, and regional or subregional shopping centers.

UC - is commercial land predominantly used for distribution, or merchandising goods and services. Stores, hotels, offices, parking garages, apartment buildings and smaller warehouses are usually set close to streets having a close pattern.

UH - is highway commercial land used for merchandising goods and services to the traveling public away from urban centers. Gas stations, motels, restaurants, drive-ins and stores located in strips along major routes of travel make up this type.

US - is shopping centers away from the urban core which are surrounded by large parking lots and may have some landscaping and trees as part of the complex.

6. Industrial (I) Will include light and heavy manufacturing, industrial parks, oil refineries and tank storage areas.

UI - is heavy industrial land containing facilities for the manufacture, storage and assembly of raw for partially processed products such as machinery, metals, chemicals, petroleum, or electrical power. Such industries often have large smokestacks and large storage areas. Warehouses and transportation facilities for bulk products and an open and interrupted street pattern characterize this type. Air and water pollution as well as unsightliness are often characteristics of heavy industry.

UL - is light industrial land containing facilities for the manufacture or assembly of smaller, partially processed products such as electronics, appliances, and other secondary process products. Large smoke-stacks or raw material storage facilities are never present, air and water pollution are seldom a problem, and light industries are not apt to be unsightly. Many modern light industries are indistinguishable from commercial activity. Most office and research use not included in urban commercial (UC) is included in this category.

7. Extractive (X) Will include sand and gravel operations and other mining.

SG - Sand or Gravel - This land is used for the extraction of sand or gravel.

OM - Other Mining - This land is used for the extraction of stone and materials other than sand or gravel. Mining sites, though ugly to most, are fascinating to rock collectors.

8. Disposal Sites (D) Will include dumps, automobile graveyards and filter beds or sewage treatment plants.

D - Dump - This land is used for dumping waste and refuse materials such as tin cans. Active sanitary land fills would fall into this class.

DA - Automobile Dumps - Automobile graveyards or active automobile junk yards.

FB - Filter Bed - This is land and associated buildings used for treating liquids containing organic or chemical matter.

9. Transportation (T) Will include major highways, airports, railroad yards, port and dock facilities and terminal freight and storage areas.

UTA- is airports with landing strips, hangers, parking areas and related facilities. Small airfields without runways, hangers or other specialized facilities are not typed as airports.

UTW- is docks, warehouses and related land based storage facilities for water transportation and commercial fishing. Liquid storage facilities like tank farms are classified as the transportation type they are associated with.

UTR- is railyards, terminal freight and storage facilities as well as rail stations for passengers. May include liquid storage facilities like tank farms.

UTT- is terminal freight and storage facilities for truck freight. Bus terminals are included in this type. Transportation facilities which are part of an industrial complex are included as part of the industry.

HW - is divided highways with 200 feet or more of right-of-way width.

10. Public, Institutional (PI) Will include governmental, educational, health, religious and penal institutions, cemeteries and developed military installations.

UP - is public or quasi-public land with "grounds" and green space which contains facilities to serve large numbers of people. Examples are: Schools, colleges, churches, state hospitals, prisons, etc.

† - is cemeteries. The cross symbols for older cemeteries are on the U.S.G.S. base map. New cemeteries are added to the map.

11. Open Space and Outdoor Recreation (OS) Will include public and private open space land and recreational facilities.

RM - is marinas.

RFB- freshwater sandy beach. This type includes bathhouses, parking and related facilities.

RSB- saltwater sand beach. This type includes bathhouses, parking and related facilities.

RS - is swimming pools when the complex including bathhouses and parking facilities is three acres or more in size.

RC - is tennis courts where the complex is three acres or more in size.

RG - is golf courses. This type includes the clubhouse and associated recreation facilities. If the tennis or swimming facilities at country clubs exceed three acres they will be typed as RS or RC.

RD - is driving ranges or skeet shooting ranges.

RPG- is playgrounds. A conglomeration of many types of playground facilities which may include tennis courts, swimming pools and athletic fields. If, however, any of these are 3 acres or more in size, they are separated out.

RSK- is ski areas for alpine skiing. This includes ski trails with the wooded space between them as well as the base facilities and parking area.

RT - is race tracks for horses, dogs or cars.

RA - is athletic fields and stadiums.

RAP- is commercial amusement parks.

RFG- is fairgrounds for agricultural fairs.

RI - is drive-in theaters.

RP - is an urban park or "common"; intensively used "green space" in the city. A zoo would fall in this class.

12. Open transitional (OT) Will include abandoned fields and orchards, unused tillable land, undeveloped urban land, sandy areas with little vegetation and exposed rock areas.

AF - is abandoned field which is reverting to wild land. Woody vegetation and grass are abundant but tree crown cover is less than 30%. If the crown cover were greater than 30%, the land would be classified as forest. This land is highly productive of wildlife. Most of this land was pasture or wild hay land before abandonment.

AO - is abandoned orchard. In addition to the decadent fruit trees, grass and woody vegetation are abundant in this type.

UO - is open undeveloped land which is lying idle in the midst of urban areas or adjacent to them. Such land awaits an opportune time for development of an unknown kind.

H - is the heath plant community as well as grass, shrubs, and other low vegetation found on poor sandy soils on Cape Cod and the adjacent islands.

S - is land areas which may support scattered herbaceous vegetation. Sandy beaches are a separate outdoor recreation type.

PL - Powerlines or other rights-of-way 100 feet or more in width maintained through wooded areas or buried telephone lines or gas or oil pipe lines, or lands occupied by electric transformers. Where powerlines cross agricultural or wetland and require no maintenance they are typed as the vegetative type or the use permitted under them.

13. Agriculture - Cropland (AC) Will include orchards, nurseries, cranberry bogs and tilled land.

T - is tilled or tillable crop land which is or has recently been intensively farmed. The boundaries on the ground are usually sharply defined and well maintained because the land is valuable. The land supporting farm buildings is included as part of this type.

TU - is unused tillable land which has not recently been tilled and is not part of an agricultural unit. This kind of land occurs near growing urban areas and is usually mowed annually to maintain its value.

O - is productive fruit orchard.

N - is land supporting nurseries. This type would include greenhouses and land adjacent to them as well as lands supporting horticultural specialties, ornamentals, shrubs and Christmas trees.

CB - is productive cranberry bog.

14. Agriculture - Pastureland (AP) Will include livestock, poultry, or dairy farms and land in grass being used primarily for grazing.

P - is pasture or wild hay land which is not suitable for tillage due to steepness of slope, poor drainage, stoniness or lack of fertility. This land has less sharply defined boundaries and often has occasional scattered shade trees for the grazing animals.

15. Forest (F) Will include public and non-public lands with at least 30% tree cover.

S - softwoods constitute at least 80 percent of the stand.

H - hardwoods constitute at least 80 percent of the stand.

HS - a mixture of hardwoods and softwoods with hardwoods predominating.

SH - a mixture of softwoods and hardwoods with softwoods predominating.

P - plantations are indicated by appending the symbol P to the forest type symbol.

16. Wetland - Coastal (WC) Will include lands regularly or irregularly flooded by salt water.

TSM- is tidal salt marsh which is flooded twice daily. Vegetation is primarily saltmarsh cordgrass.

ISM- is irregularly flooded salt meadows, flooded at monthly high tides and during severe storms. Vegetation is primarily saltmeadow cordgrass, saltgrass and black rush.

DSM- is irregularly flooded salt meadow which has been ditched for mosquito control or for agricultural purposes.

17. Wetland - Inland (WI) Will include bogs, swamps, marshes and flats or meadows covered seasonally or longer in fresh water.

SF - is seasonally flooded basins or flats. The soil is waterlogged or covered with water during spring freshets, but well-drained during the growing season. This type occurs principally on steam floodplains and the most common plants are grasses and herbaceous species.

B - is bog. The typically acid, peaty soil is waterlogged and supports a distinctive plant community which usually includes most of the following; heath shrubs, cranberries, pitcher plants and sedges. Scattered black spruce, tamarack and red maple may be present. A mat of sphagnum moss is the most characteristic feature of bogs.

SS - is shrub swamp. The soil is waterlogged during the growing season and is often covered with as much as six inches of water. Common woody species are alder, buttonbush, dogwood and willow. Sedges are usually present in tussocks.

M - is meadow. The soil is waterlogged through most of the growing season and surface water is present only for a short period during the spring. Vegetation is predominantly grasses, rushes and sedges. Rushes, which grow in the wetter parts of many meadows, photograph very darkly marking this type easy to identify.

SM - is shallow marsh. This type is wetter than meadow. The soil is completely waterlogged and often covered with up to six inches of water during the growing season. There is usually some open water and the predominant vegetation is emergent, including such plants as cattails, bulrushes, burreed, pickerelweed and arrowhead with some grasses and sedges present.

DM - is deep marsh. Water depth ranges from six inches to three feet. Fairly large open water areas are bordered by, or interspersed with, emergent vegetation like that found in shallow marsh. Floating and submergent plants such as water lilies, duckweed, watershield and pondweeds are also present.

BP - is beaver pond. These ponds resemble one or more of the above types but they owe their origin to beaver.

18. Water (W) Will include natural ponds and lakes, artificial ponds, streams and rivers. Salt water is not included.

W - is fresh open water in lakes and large streams. Water depth is greater than three feet during the growing season.

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